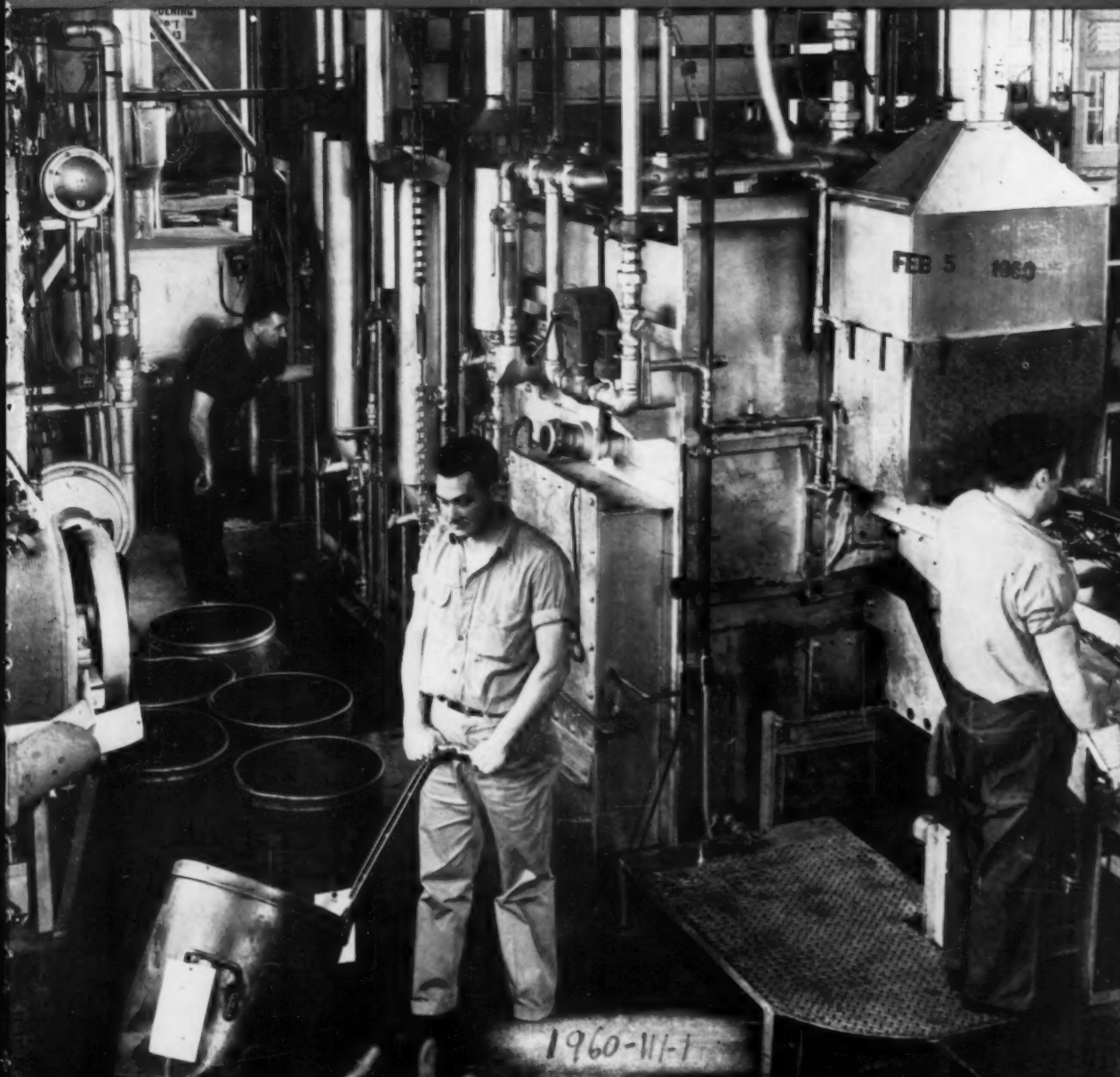


Metal Treating

JANUARY 1958
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THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

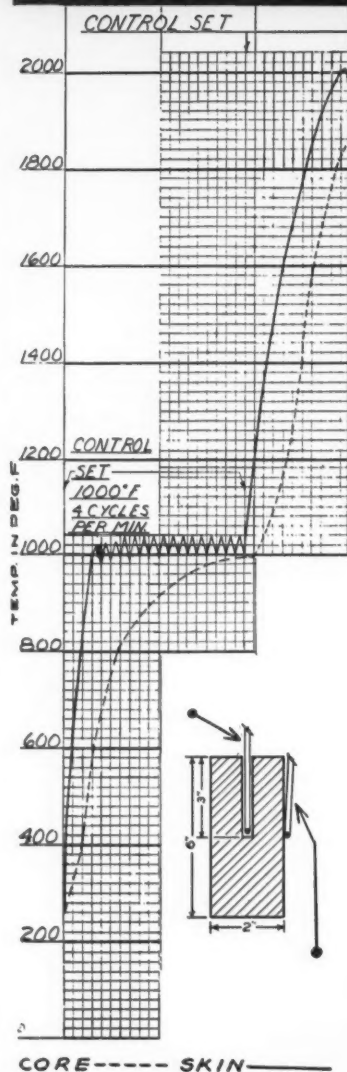


A U-shaped installation of continuous hardening, quenching, and tempering equipment used for the heat treatment of springs (See page 2).

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TABLE OF

C O N T E N T S

ARTICLES

Some Spring Heat Treating Practices Defined by James Maker	2
Salt Baths and Salt Bath Furnaces (Part I) by Haig Solakian	4
Special Techniques in Vacuum Metallurgy (Part II) by Michael Rivera	8

FEATURES

What Would You Do? ... 14	News to Heat Treaters ... 30
Heat Treating Hints ... 16	Letters to the Editor ... 39
Abstracts ... 18	Manufacturers' Literature ... 44
The Apprentice Corner ... 22	Equipment and Materials Directory ... 50
M. T. I. Activities ... 29	Index to Advertisers ... 52

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Indexed in Engineering Index



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SOME SPRING HEAT TREATING PRACTICES DEFINED

By **JAMES MAKER**, Metallurgist
Wallace Barnes Division,
Associated Spring Corporation,
Bristol, Connecticut

THE PURPOSE of heat treating springs is to obtain the highest possible elastic strength, so that the springs will absorb large deflections without setting. This contrasts with the objective in heat treating machine parts, which is generally to increase their toughness and wear resistance.

The materials used in the manufacture of springs are mainly carbon steels, usually in the .60 to .80 carbon range but often of SAE 1095 analysis. Some alloy steels are used, but these are restricted principally to SAE 6150 (chrome vanadium) and SAE 9254 (chrome silicon). Other materials used include beryllium copper, stainless steels, and high nickel alloys.

The best spring-making practice is to use pre-tempered materials—that is, materials which have been hardened before fabrication and are of at least the hardness desired in the finished product. Pre-tempering can be described briefly as the hardening and tempering of spring material continuously in a sequence of operations with the hardening pass followed by a quench, followed by a reheat until the final hardness is achieved. The use of pre-tempered materials wherever possible reduces inspection of the finished springs and has other advantages in metallurgical re-

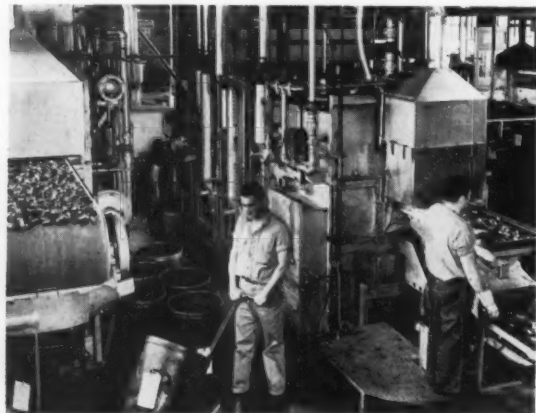


Fig. 1—An overall view of the U-shaped installation of continuous hardening, quenching, and tempering equipment used at the Wallace Barnes Division of Associated Spring Corporation.

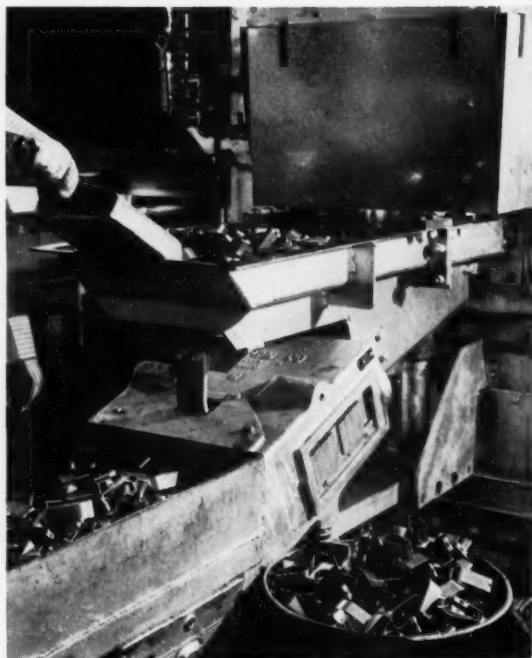


Fig. 2—Springs are loaded on this vibrating feeder (see also right foreground in Fig. 1), spread out on the cast link belt conveyor and conveyed through the hardening furnace. They are dropped into a quenching bath at the end of the furnace.

sults. But even these must be heat treated after forming to relieve the stresses produced during the forming operations.

However, many types of springs cannot be made from pre-tempered material but must be made from soft material. Automobile valve springs are made exclusively from pre-tempered material, but aircraft valve springs are made from soft material and hardened after forming. Springs of small index number (that is, the ratio of spring diameter to wire diameter) cannot be made except from soft material. There are other advantages from the use of soft material, including the fact that the inventory of raw material can be reduced.

Consequently, when material of "spring temper"

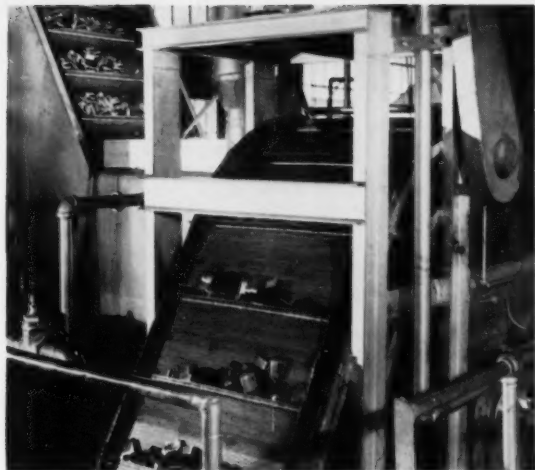


Fig. 3—This conveyor belt is elevating the springs out of the quenching oil and dropping them into a washer where the oil is removed by a bath of hot water containing a detergent. In the rear is seen another conveyor belt taking the springs to the drawing furnace (see also left foreground in Fig. 1).

cannot be used, then soft material is the alternative. Non-ferrous metals are quenched soft and merely reheated. Steel, however, must be hardened and then drawn. Several procedures are available; ordinary oil quenching and drawing to the desired hardness, austempering to the same hardness, and martempering by quenching in salt at 425°F. and then drawing to the same hardness.

Precise Control Needed

The spring manufacturer must produce consistently uniform products. This means that his heat-treating operations must be precisely controlled and checked. He must attain full hardness, while at the same time minimizing the distortion of flexible and often delicate parts. Also he must prevent decarburization, and in some cases he must restore lost carbon to the surface material where the stresses are concentrated.

The operating stresses of springs are higher than those encountered in any other field of engineering. This means that the spring maker must work to very close hardness limits in order to keep a proper balance between set point and toughness. Moreover, he must use stress relief to control accumulated internal stresses, and he must frequently give the springs a further finishing operation to avoid undesirable stress concentrations.

At each of the divisions of Associated Spring Corporation, thousands of pounds of springs are heat treated every day. The treatment given ranges all the way from a simple stress-relieving of inexpensive, cold-drawn, wire springs to the elaborate and precisely controlled hardening and fixture-tempering of "aircraft-quality" springs.

Operations are further complicated by the fact that hundreds of lots flow into and out of the shop in rapid succession during each working day. The treat-

ment to be given each lot may vary considerably from batch to batch. We have, therefore, had to devise a mistake-proof system for keeping track of every job and for giving processing instructions. Each lot is tagged with a job-ticket which lists all the operations to be performed, and is then trucked directly to the area where the first of these is to be done. Copies of these operation-sheets are kept in the foreman's office to prevent a job from being side-tracked. As each operation is performed on a lot of springs, it is duly checked off on the job-ticket, and the job number and the time spent on it are reported to the time-keeper.

Restrictions Encountered

The hardening of steel springs requires considerably closer atmosphere control than is needed for many machine parts. The principal reason for this is to prevent decarburization. Consider a highly stressed spring made of flat stock .020" thick. If a decarburized layer .002" thick is allowed to form, the strength of the material will be lowered for 20 per cent of the distance from the surface to the center of the stock—i.e., in the most highly stressed portion of the spring.

Another restriction imposed on the spring heat-treater is the problem of preventing distortion. Normally, small parts are hardened by loading them into a deep basket. But if this were attempted with springs, the weight of the load would crush the springs at the bottom and throw them out of tolerance when the springs approached the hardening temperatures.

Furnaces Used

For this reason, a considerable volume of our hardening operations is carried out in shaker-hearth furnaces, with hearths 12" to 16" wide. These spread the work out in a single layer and thus prevent any distortion due to pile-up.

Another advantage of the shaker-hearth furnace is its short processing cycle. Springs are exposed to the atmosphere for only 10 minutes or so, which means

(Continued on page 36)



Fig. 4—Some typical springs whose maximum elastic strength is obtained by heat treating.

SALT BATHS AND SALT BATH FURNACES

By HAIG SOLAKIAN, Sc. D., President
The Bellis Company and Crown Chemical Corp.
Branford, Connecticut

Editor's Note: It was felt that to reduce this article in length to fit one issue would be to sacrifice its value, hence this is Part I of two parts.

THE PHYSICAL PROPERTIES of a metal are dependent, primarily, upon its composition and microstructure. With a metal of a certain composition, its microstructure and physical properties, such as hardness, strength, machine-ability, wear and shock resistance, can be altered by heat treatment, to suit a specific purpose. Hence, most metals, ferrous or non-ferrous, before they become the finished product, receive one form or another of heat treatment. Thus the heat treater renders a service, perhaps not often appreciated, touching upon every phase of our modern progress.

The expression "Heat Treatment" is used here in a broad sense, and may mean one or more of the operations such as—

- (a) Heating the metal to a predetermined temperature and holding for the necessary length of time.
- (b) Cooling the metal to room temperature, either slowly, resulting in annealing, or rapidly by quenching in oil or water, resulting in hardening.
- (c) Tempering or drawing to relieve stress and to impart the desired toughness to the tools, or to age the metal as in aluminum alloys.
- (d) Heating the metal in a carburizing compound to introduce carbon to the surface to develop a wear resistant hard case.

In general the above are the main factors involved in the heat treatment of metals. These operations cover a temperature range from 300° to 2350°F. For convenience as well as for practical reasons, we should like to divide these heat treating operations into three temperature ranges; namely, low — 300 to 1150°F.; intermediate — 1200 to 1850°F.; and high — 1850 to 2350°F. To carry out operations within the above ranges, for a heating medium, air, controlled atmosphere or a molten salt bath may be used. However, since we will consider, in this article, only the salt baths as a heating medium, we will discuss various types of salt baths to be used within each range outlined above, and the suitable furnace equipment adaptable for that temperature range.

I. Low Temperature Range—(300°-1150°F.) A. Salt Baths:—300°-1150°F.

The most commonly used salt baths within this range are various mixtures of nitrates and nitrites of sodium and potassium, known as tempering salts. With such a mixture a bath completely liquid and usable at 300°F. can be obtained. If a salt bath with a lower operating range is desired, lithium nitrate may be utilized. Twenty-five percent by weight of lithium nitrate added to a conventional tempering bath would lower its operating temperature close to 250°F. The need for such a salt bath is rather rare, and the high cost of lithium salt prohibits its extensive use for such applications.

Another salt bath, less commonly used, is a mixture of sodium and potassium hydroxide. The lowest temperature such a mixture can be used at would be around 365°F., and it can go as high as 1250°F. Of course, being strongly alkaline and extremely hygroscopic, its use has been limited to special applications, which will be outlined later on.

A third type of salt bath to operate below 1150°F. is a sodium cyanide base compound, with several components added to lower its melting point and control its rate of breakdown. This particular salt bath normally operates between 950° - 1050°F.

A fourth type is a neutral bath consisting of a mixture of chlorides of sodium, potassium, calcium and barium. Such a bath can operate at 1000°F. and above, up to 1550°F.

Before taking up the various types of furnace equipment to operate with these salt baths, we may mention some of the common uses and applications of each salt bath outlined above.

- a) The tempering baths may be used for the following purposes: tempering ordinary tool steels 300° - 350°F., or high speed steels 1000° - 1150°F.; spring tempering 600° - 800°F.; gun metal coloring 650° - 800°F.; black coloring 1000°F.; stress relieving and annealing non-ferrous metals such as silver, copper, brass at 600° - 1150°F.; solution treatment of aluminum alloys 935°-975°F.; aging of the same 350°-450°F.; and aging of beryllium copper 450°-650°F. In

addition, these baths may also be used for marquenching and ausquenching 400°-850°F. and for instrument calibration.

- b) The alkaline baths may be used for descaling and de-sanding ferrous castings, bright tempering without oxide coloring and marquenching and ausquenching from a carburizing bath.
- c) The cyanide bearing, low temperature, compound known as nitriding bath, is primarily used for nitriding high speed steels after they have been hardened, tempered and finish ground. The nitriding temperature should always be 25°-50°F. lower than the tempering temperature to avoid size change. This bath may also be used for nitriding air hardening and stainless steels. High speed steels are nitrided for six to sixty minutes depending upon the size and their application; that is, the material they are to cut. Air hardening and stainless steels are nitrided for two to eight hours, sometimes longer to obtain a case depth of .003" to .004". Where the high speed steel tools are used on extremely abrasive materials, such as bakelite, hard rubber, or cast iron, the nitriding treatment usually increases the efficiency of the tool several hundred percent.
- d) The low temperature neutral bath may be used for tempering, annealing, stress relieving at 1000 - 1150°F.

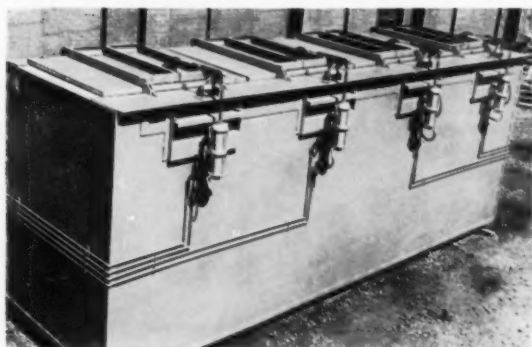


Fig. 1—One of the largest electrode furnaces used for solution treatment of aluminum alloys. Pot size is 5' wide, 6½' deep and 20' long.

Here a word of warning is necessary.

- a) Tempering baths are unstable above 1150°F. and should not be overheated beyond this temperature, otherwise they decompose and attack the pot whether plain steel or alloy.
- b) Tempering baths should not be mixed with liquid carburizing or cyaniding baths. Basket fixtures used in one should be washed and dried before using in the other.
- c) Avoid contaminating neutral baths with the alkaline baths.

I. Low Temperature Range—(300°-1150°F.) B. Furnaces.

To run a salt bath furnace at these low tempera-

tures either gas or electricity may be considered. Often the choice is dictated by the relative cost, the particular application, and also by the size of the equipment required. Normal production of a fair sized plant, whether tempering, descaling or nitriding, can easily and satisfactorily be taken care of by a gas fired furnace. The size of the pot, usually made of pressed steel, and of the furnace, will depend upon the size and amount of work to be processed.

A gas fired furnace with a pot, say 18" diameter x 24" deep, can temper in thirty-minute cycles about 500 pounds of steel per hour; or, a furnace with a 10" diameter x 16" deep pot, can easily take care of nitriding of most high speed tools used in an average plant. Of course, the size of pot and furnace can be chosen best suited to the sizes and quantities involved. Where production is light, a furnace with venturi burners utilizing air at atmospheric pressure may be employed. Such furnaces do not need blowers and will operate very economically. However, where production is heavy, a blower may be needed to provide the necessary heat. In such a furnace air is introduced at a pressure of 8 to 16 ounces.

Resistance-type furnaces are satisfactory for operations within this range; however, the size of the pot required will limit its application.

Electric furnaces may be electrode, calrod or resistance ribbon type. These all have wide range of flexibility as to the size of the pot.

We stated above that the choice of gas or electric type of furnace often is dictated by the size of the pot required. This point is more clearly appreciated when we consider the heat treating of large duralumin parts for aircraft. Here, often a pot size 5 feet wide, 20 feet long and 6 feet deep may be required. To heat such a pot by gas would not be too practical. A tremendous amount of heat has to be forced from the combustion chamber into the pot. Under such conditions heating the pot uniformly becomes a serious problem. In addition, the pot life may be shortened due to possible localized overheating, thus necessitating costly replacement and repairs. For these reasons when an exceptionally large pot size is involved, it would be better to heat it either by immersed calrod heating elements or by electrodes. The service life of calrod type heating elements is not as satisfactory as that of electrodes. Many of the users of furnaces of large dimensions have favored the use of electrodes, which not only have several years life expectancy, but also have the advantage of generating the heat precisely where it is needed and utilized, right in the salt bath itself. Such large furnaces are shown in Fig. 1.

II. Intermediate Range—(1200°-1800°F.)

A. Salt Baths.

As we go higher in temperature, the chemicals or salts available and suitable for such applications become fewer. To operate properly within the above

range for neutral hardening, we are limited practically to four chemicals; namely, sodium chloride, potassium chloride, calcium chloride and barium chloride. Occasionally, strontium or lithium chlorides also are used, but they have no outstanding merit and their cost further prevents their extensive use. By manipulating the percentage of each, a stable compound can be developed to cover the above range. If the salt bath is to be used primarily for the heat treatment of water or oil hardening steel, the compound mostly would be a mixture of sodium and potassium salts with some rectifiers. If the salt is to be used near or at the upper range, the barium salt would be the predominating chemical.

All these neutral salts, no matter how stable they may be, undergo certain changes and they break down, slowly but surely, at the prolonged operating temperatures. The higher the temperature, the faster the breakdown. They first break down into oxides, which gradually oxidize through the action of the air, into carbonates. Presence of carbonates in the salt bath is undesirable because they cause decarburization or soft skin on tool steels. This condition usually is corrected by adding what is known as rectifiers, such as borax, boric acid, silicon carbide, or molybdenum silicide a few ounces at a time; also by bubbling methyl chloride gas through the bath.

In this connection another point needs to be cleared up. If the neutral salt bath is operating in a pressed steel or alloy pot, some metal is oxidized and washed into the bath. These metallic oxide particles, often very small, float in the bath, and if the percentage of these oxides reaches 2.5 or 3, they will begin to decarburize the tool steel. For this reason a rectifier like borax or boric acid becomes necessary. Borax, in particular, reacts readily with metallic oxides and converts them into a harmless sludge that settles in the bottom of the pot and can be removed with a ladle. A simple method to check the condition of the salt bath as to whether it is broken down sufficiently to cause decarburization is to take a one gram sample of the bath in the pot, (this may be done by immers-

ing a clean rod, say $\frac{1}{2}$ " - 1" in diameter into the bath and withdrawing immediately and collecting the adhering salt in a clean box or can), adding to it about 100 cc tap water, heating to gentle boiling for one or two minutes, filtering through a #1, 12½ CM Whatman's filter paper, adding 2 to 3 drops of methyl red indicator, and titrating with tenth normal hydrochloric acid to a permanent pink end point. A satisfactory bath should not require more than 3 cc hydrochloric acid to reach the end point. If the bath requires more than 3 cc, then one ounce of rectifier for every 100 pounds of bath in the pot should be added to the bath, allowed to react for 4 to 5 minutes, and then any scum that developed removed before processing any work through the bath.

In operating a neutral bath for the hardening of tool steels, two factors should be carefully considered:

- The proper temperature, which depends upon the analysis of the steel; and
- The proper timing of the tools, which depends upon its size. Neglect of one or both of these factors will result in obtaining an inferior tool. Chart #1 shows the relationship between the size and the time in bath, and should serve as a guide.

There is another class of salt baths, operating within the intermediate temperature range, namely liquid carburizing baths, which needs to be considered now. All these baths have sodium cyanide in various percentages as the basic constituent, compounded with several other chemicals, such as barium chloride, potassium chloride, sodium chloride, sodium and potassium carbonate, sodium fluoride, silicon carbide and carbon. The actual amount or percentage of sodium cyanide is varied depending upon the requirements of the particular application. Where a shallow case is specified, say .003 to .006", the percentage of sodium cyanide is rather low, (around 30 to 35%), and where deeper case, .10 to .020" is desired, the percentage in the compounded bath is higher (40 to 50%). The salt bath manufacturers have more or less standard products with varying amount of sodium cyanide to meet the specific needs of a user. The depth of case to be produced on a low carbon steel depends upon two main factors: a) the time; and b) the temperature. This relationship is illustrated on Chart #2.

Since sodium cyanide is the most important constituent in a liquid carburizing bath, its stability and breakdown is of paramount importance. Of course, certain degree of breakdown is necessary to generate the carbon and nitrogen to case the steel, but uncontrolled, rapid breakdown is wasteful, and causes premature failure of the bath.

To avoid the rapid breakdown of a liquid carburizing bath a definite amount of carbon is incorporated into these baths. The carbon floats on top of bath and serves two definite purposes. It provides

(Continued on page 49)

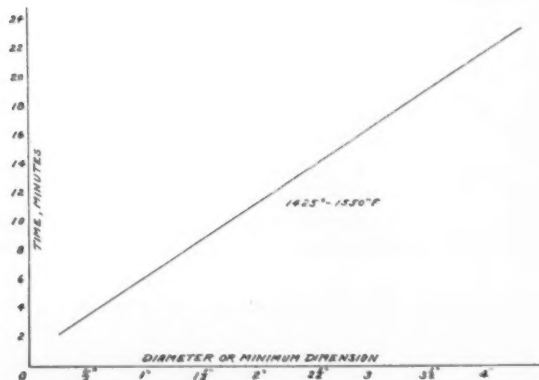


Chart #1—The relationship between the size of parts and the corresponding timing in the bath.

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SPECIAL TECHNIQUES IN VACUUM METALLURGY

By **MICHAEL RIVERA**

Vacuum Equipment Division
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New York, N. Y.

Editor's Note: This is the concluding instalment of the article, Part 1 of which appeared in the November-December issue.

High Frequency Furnaces

High frequency heating of vacuum furnaces is used not only for melting, pouring and casting, but also for sintering, brazing, degassing and annealing. The conditions and characteristics of the self-heating of materials under low pressure are unique and thus present a very promising tool to the field of heat treating.

The heating of masses under vacuum by inductors can be accomplished with the inductor coil either outside the vacuum or inside. Inductors are often placed outside the vacuum in order to allow coil operation at higher voltages. Since the output of tube and spark gap type power supplies is at higher voltages, operation under vacuum may give rise to power leak or coil arcing and glow discharges. This represents dissipation of power into the gas remaining in the chamber, rather than in the workload as desired. Thus, some coils are operated at atmospheric pressure, around vacuum chambers constructed of non-conducting materials such as quartz or Vycor. Such furnaces are most commonly built in the form of vertical cylinders and are used for the outgassing of vacuum tube components, the drawing of single crystals for semi-conductors, for brazing, melting, and other processes.

Sometimes the inductor coil is placed within the vacuum tank in order to obtain closer spacing between the coil and the work and thus achieve better power coupling. Working within a larger tank allows room for other fittings, operations and manipulations such as tilting, casting, etc. Certain vacuum brazing operations on small parts may be accomplished in modular furnaces such as that shown in Fig. 1. Since higher frequencies (i.e., above 20 KC) are often desirable for work of this sort, a high frequency step-down transformer is often used to avoid difficulties with arcing and flash-over in vacuum. Thus, high voltage output of a power supply is converted to a lower voltage before entry into the vacuum chamber.

The use of motor-generator power supplies for vacuum furnaces is greatly expanding. Their voltage

output is low (i.e., below 400 volts), allowing direct entry into the vacuum systems. They operate in the range of 960 to 10,000 CPS and therefore are capable of handling varying loads. High power is easily controlled.

Another type of furnace is that in which the high frequency energy heats the workload indirectly by heating a susceptor. Furnaces with refractory metal or carbon susceptors are used to obtain very high temperatures (above 3632°F.) for vacuum sintering, melting, degassing and annealing of reactive and refractory metals.



Fig. 1—A modular assembly with a resistance heater power supply, a high vacuum pumping system and a high temperature furnace unit.

The susceptor is usually a cylinder surrounding the workload, and its material is chosen upon consideration of its vapor pressure, mechanical stability, the nature of the workload and process, and possible contamination of the work by the susceptor material. Tantalum, tungsten, molybdenum or carbon are commonly employed for susceptors. For minimal contamination the susceptor may be made of the same material as the work. For example, carbon susceptors are used for the degassing of carbon boats used in conjunction with germanium and silicon work.

Where necessary, shielding of the susceptor may be provided by either spiral radiation shields (which do not form a closed path for the absorption of power) or insulators such as alumine, zirconia, quartz, etc. Workloads are placed on refractory metal tables within the susceptor or are raised or lowered into the heater volume in a suitable refractory metal container, thus allowing freedom from contamination (as from ceramics).

Isolated workloads, heated directly by the inductor coil, will have a higher temperature than any other component in the furnace. This facilitates obtaining highest purity of the work, since migration of impurities (by diffusion and evaporation) will be away from the self-heated work to any cooler surface in the furnace.

Construction of these furnaces is usually fairly critical and specialized for the individual application. Although small units can be built as accessories for existing furnaces, it is frequently best to start from the ground up and design a complete furnace to do the job when production sizes are needed.

Arc Melting

Arc melting is a definite field of its own in vacuum metallurgy. In some cases, vacuum is used only for the original purging, whereas in other cases the arc melting process is carried out under an optimum low pressure. Arc furnaces for melting, alloying and consolidation of powders, sponge and scrap of various metals are available for either inert gas or vacuum operation.

Fig. 2 shows an arc melting furnace for inert gas operation with vacuum purging. It consists of a water-cooled copper mold, a water-cooled non-consumable tungsten electrode, a Vycor cylinder chamber and a mechanical vacuum pump. Water-cooled hearths of various mold sizes and configurations are interchangeable.

Temperature Control

Temperature monitoring and control of vacuum furnaces is carried out with the same type of instrumentation as is used for furnaces operating at atmospheric pressure. Thermocouples of chrome/alumel, platinum/platinum 10% rhodium, and platinum/platinum 13% rhodium are commonly used in conjunction with pyrometer indicators, recorders, and controllers.

Since platinum couples are limited to about 3092°F. monitoring the higher temperatures can present a problem. Optical pyrometers are used to measure the highest temperature by sighting the charge through observation ports. However, gross errors in observed temperature can result due to reflection and absorption of light by films deposited on the ports by evaporation of material from the heated charge. Also, optical pyrometers are limited to intermittent readings, thus making them unsuitable as monitors for temperature control feed-back systems. Temperatures up to about

3992°F. can be continuously monitored with special thermocouples—one of which is made of tungsten and iridium. These can be of great value, provided that they are used with due precautions to their particular limitations.

As requirements for temperature constancy become more rigid, the degree of automation in control increases. There are, however, differences in the possible modes of control of muffles and retorts compared to cold-wall furnaces. These arise mainly because they differ in heating and cooling rate time constants.

Muffle furnaces are controlled in much the same manner as ordinary furnaces operating at atmospheric pressure. Power control can be achieved by changing taps on transformers or by using auto transformers. The wiring scheme of heater units can be changed on a switchboard; various combinations of changes, such as parallel to series or delta to "Y", afford discrete changes in resistor load and thus in power input. Automatic control is achieved by thermocouple feed-back systems. Controllers are available to operate magnetic contactors to give two-position (on-off) or three-position control of power input. This general type can similarly be used to change wiring combinations, thus allowing finer control than simply 100% on-off. The two-position type are also available with a proportioning control. These maintain a constant frequency of contact and adjust the power "on" time to be proportional to the deviation of the temperature from the set point. Finer control and elimination of



Fig. 2—An arc melting furnace for inert gas operation with vacuum purging.

contactor maintenance are obtained by using stepless control units such as ignitrons and saturable reactors. These can be driven by slidewire pyrometer controllers to give proportional control or proportional in combination with reset and rate, depending upon the thermal lags, positioning of the thermocouples, etc.

Power control for the higher temperature cold wall furnaces is generally restricted to certain types. These furnaces generally have much shorter time constants of heat-up and cooling than muffle furnaces. This occurs because power transfer is by radiation, the heaters are mounted near the workload, and masses within the hot zone are relatively small, thus minimizing thermal inertia. Power control is therefore mostly of the "stepless" variety, achieved by auto transformers and reactors. Good control is obtained by proportional controllers if the workload does not vary. Changing workloads (materials transferred into and out of the hot zone) require a reset feature to avoid droop or off-set. A saturable reactor driven by a control signal, combining variable proportional reset and rate functions, is one of the best systems for obtaining close control in furnaces that have many factors causing temperature drifts, such as heating lags or power demand changes.

Furnace Facilities

Brief descriptions have been given of various basic high temperature metallurgical furnaces and their components. These furnaces are combined with vacuum pumps, work-transfer devices and power control systems to give fully integrated processing facilities. The design and size of a furnace, the planned work capacity and extent of automation are functions of output requirements vs. initial cost of equipment. As examples of vacuum equipment for heat treating to show the extent of facilities that are available, two vacuum furnaces are cited.

Brazing Furnace

Fig. 3 shows a vacuum furnace for production of brazed components. It is a pilot plant and thus incorporates flexibility in its mechanical and electrical operating characteristics. The two-chamber system is built symmetrically and allows efficient utilization of jigs, fixtures and operator's time.

The vacuum system consists of three Kinney 130 CFM mechanical pumps, two Kinney 10" diffusion pumps, freon-cooled poppet valve-baffles and a roughing line with safety interlocked pneumatically operated valves. One of the mechanical pumps is a roughing pump for both tanks. Pumping to lower pressures is carried out by a diffusion pump backed by a mechanical pump. The poppet valve-baffles are also pneumatically operated. Roughing and fine pumping are quickly and conveniently carried out by operating the valve switches on the panel board.

The work pieces are loaded on a platform in the lowered vacuum tank floor; this is automatically raised,

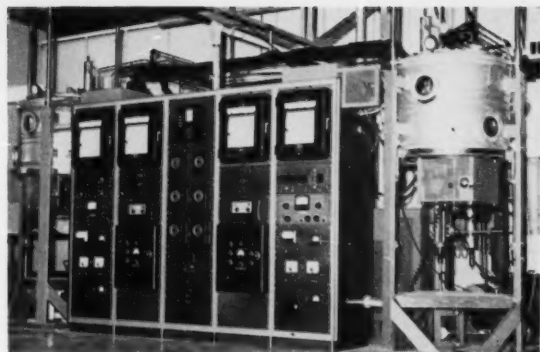


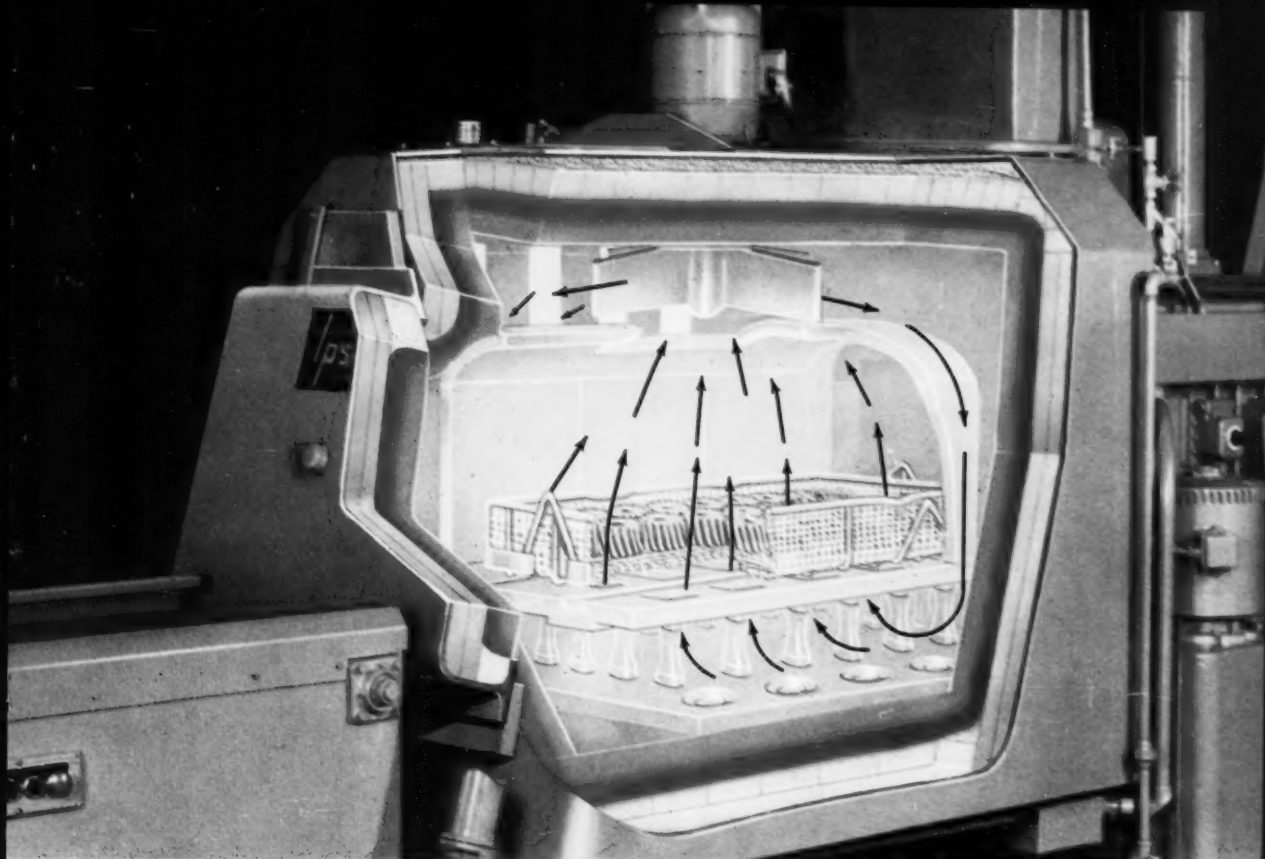
Fig. 3—A vacuum brazing pilot plant installation with a two-chamber system.

bringing the work into the furnace and sealing the tank for evacuation. The work platform is annular, and it is driven by a variable speed motor. The annular furnace is divided into zones, so that the work travelling through is subjected to varying temperatures.

The heating elements are formed of molybdenum rods, which are curved to conform to the annular furnace design. Radiation shielding minimizes power losses from the furnace sides, top and bottom. One of the novel features of this unit is the movable radiation shielding from the bottom of the furnace. Since the workload is raised into position, a device is provided for automatically opening the bottom shielding when the tank is at atmospheric pressure and for closing it during evacuation. Since the workload is traveling through the furnace, and it may not have constant thermal properties, monitoring and control of power has to be accurate in order to maintain a constant temperature for the process. High temperature thermocouples are used to monitor the hot zones with a multi-point pyrometer indicator and that of the control zone is recorded on a strip chart controller. The recorder controller drives a current adjust type amplifier which allows variable proportional, reset and rate control. This output is amplified and operates saturable reactors. The saturable reactors are arranged so that each one controls power in a separate furnace zone. Potentiometers are provided to allow manual control over the individual zones. The furnace heating and cooling rates are controlled by motor-type variable heating and cooling rate timers. The excellent control over the heater power provides a constant process temperature even with a continuous variety of work progressing through the furnace.

Safety interlocks are provided in the diffusion pumps to provide alarms in case of water pressure failure or overheating of the water. The furnace power is interlocked with the vacuum pressure and the furnace temperature, so as to shut off power in case of vacuum over-pressure or furnace over-temperature.

The complete system provides maximum flexibility for determining exact operating parameters and allows closely controlled high workload output.



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100% forced convection heating and exclusive alloyed ceramic heating tubes have been successfully combined in all Ipsen furnaces for special atmosphere carburizing, carbo-nitriding, heat treating, brazing or sintering, and other applications calling for temperatures up to 2500° F.

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charge simultaneously raises the temperature of both the heating chamber and charge back to the desired control temperature.

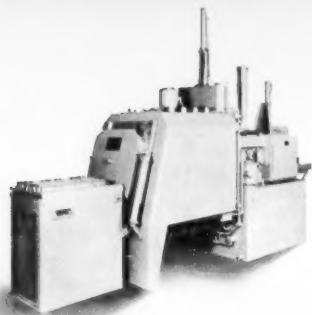
100% forced convection heating insures uniform heating of every part of the charge . . . whether it's loosely or densely packed. Both light and heavy sections are uniformly heated.

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following page
shows 100%
forced
convection
chart

how Ipsen 100% forced convection works . . .



This centrifugal roof fan, powered by a husky, slow-starting motor, circulates the protective atmosphere . . .

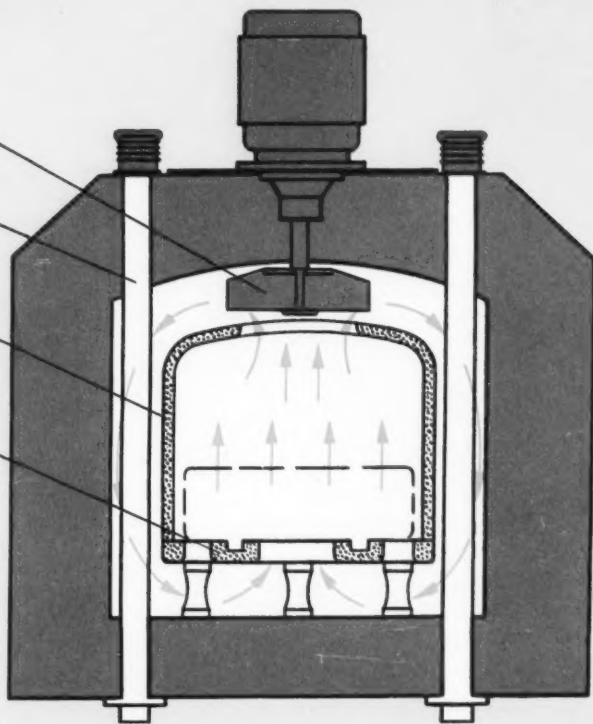
down past these vertical alloyed ceramic heating tubes . . .

which are isolated from the work chamber by this baffle . . .

to the bottom of the furnace and then up through this heavy, open grid-hearth . . .

to all parts of the charge where correct working temperature is maintained.

Work is brought to heat uniformly . . . controlled atmosphere is forced to all parts of the charge.



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High Temperature Sintering Furnace

Fig. 4 shows a high vacuum, high temperature resistance sintering furnace. This furnace has many novel and unique features. Temperatures of 3992°F. and above are available for sintering for long periods of time. These temperatures are achieved with tungsten rod elements, held in water-cooled copper conductors thus avoiding a carburizing atmosphere. Vacuum locks are provided for workload charging and discharging. Thus, the work is processed through the high temperature furnace in production fashion with the furnace itself always under vacuum. The work is transferred from the loading lock and through the furnace station on a water-cooled raisable and rotatable platform. The loading and unloading lock positions are indexed, thus simplifying manual operation of this transfer system. The main vacuum chamber is provided with sight ports to allow viewing of the transfer. The vacuum loading lock is provided with a preheating furnace to commence processing of the work while another load is heated in the high temperature furnace. This allows maximum utilization of time. The loading and unloading locks are provided with a unique transfer device, which allows engaging and transferring the workload even at high temperatures.

Separate high speed vacuum systems are provided for the main furnace and the locks. The locks are semi-independent; one can be evacuated by isolating the other. Gate valves are provided to isolate them from the main tank, and they are both evacuated through a valved manifold. This is pumped by a mechanical pump and diffusion pump with a specially designed water-cooled baffle to prevent backstreaming of diffusion pump oil vapors. The main tank, with its high temperature furnace, is evacuated with a diffusion pump backed by a mechanical pump. To minimize oil backstreaming into the high temperature chamber, the poppet valve is provided with Freon-

chilled baffle coils. Pressures throughout the system are monitored by thermocouples, cold cathode and hot cathode ionization gages.

The temperature of the furnace is monitored with a special thermocouple. Since it is desirable to continuously record on a strip chart the process temperature, and because of the inherent limitations in the use of an optical pyrometer, a special tungsten/iridium thermocouple is used to monitor the high temperature zone. Auxiliary thermocouples are provided as further check. The pre-heating furnace of the loading lock is also monitored with a Chromel/Alumel thermocouple. Heater power to the high temperature furnace is controlled by a saturable reactor. This is driven by a DC supply and provides stepless control as well as permitting convenient setting to the desired temperature. The furnace construction and shielding results in highly efficient power utilization. High temperatures can be obtained quickly. The high temperature volume is approximately 4" in diameter by 8" high, and there is an even, homogeneous temperature distribution—the best condition for high temperature sintering and other processes.

There are many types of equipment in use today for vacuum metallurgical processing with established techniques. There is no doubt that demands for new materials will encourage wider application of these methods and procedures and will also spur research into newer ones. • • •



Fig. 4—A high vacuum, high temperature-resistance sintering furnace.



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... Proved by this New Testing Method

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This new, accurate test clearly proves HOUGHTO-QUENCH "K" is the fastest quenching oil on the market today... the best and safest quench you can buy for getting maximum hardness in lean alloy steels.

The test uses a pure nickel ball, heated beyond the temperature at which it is entirely non-magnetic (1,625°). The heated ball drops into a container holding 200 cc. of the quench being tested, starting a timer the exact instant it enters the quenching bath.

At the exact instant the nickel ball has cooled to the temperature at which it regains its magnetic

properties (Curie point, approximately 670°), it is drawn to a magnet. This action shuts off the timer.

The Magnetic Quenchometer has disclosed much useful data on the excellence of the various types of HOUGHTO-QUENCH and the other Houghton Quenching Oils as well.

It's a good idea to ask the Houghton Man about Quenching the next time he calls on your plant. If you need speed, he'll show you how to get it with HOUGHTO-QUENCH, the fastest quench this side of water. Or, if speed is not your prime requirement, he can recommend from a variety of Houghton oils the one best suited to your needs.

Why not make Houghton your heat treating headquarters? Call the Houghton Man today, or write direct to E.F. Houghton & Co., 303 West Lehigh Ave., Philadelphia 33, Pa.

HOUGHTO-QUENCH IS DIFFERENT

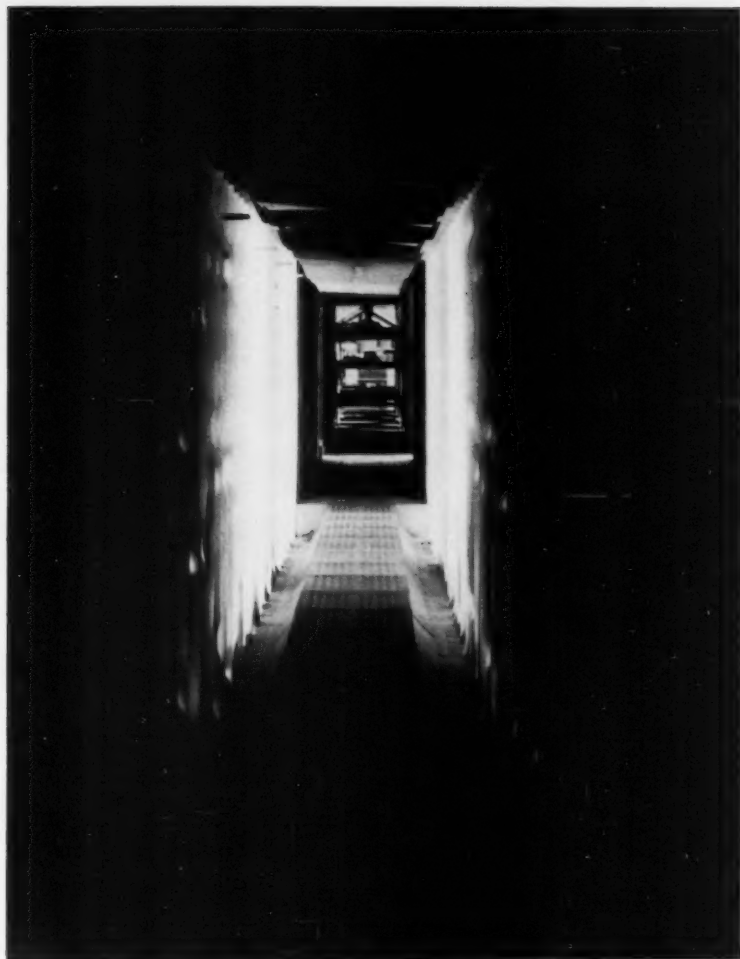
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See how dimpled Inconel radiant tubes look after full year in Lindberg furnace

This modern and efficient vertical radiant tube furnace was designed by Lindberg Engineering Company, Chicago, for the new enameling plant of Chambers Manufacturing Company, at Oxford, Miss.

Pre-heat zone, firing zone and annealing section contain 64 radiant tubes of Inconel® nickel-chromium alloy.

Look closely, and you can see how each tube has been "dimpled" to create a turbulent flow of combustion gases. What you can't see in the photo, though, is how provision has been made for fast replacement of tubes, if necessary. *You simply lift*

the old one out from the top, and drop a new tube into place.


Quick and easy as that is, you don't have to do it often. In fact, plant production manager Paul Davis says Chambers hasn't had to replace a single tube yet! After more than a year, the original 64 Inconel alloy tubes are still in service. And, he adds, still in good condition, despite operating temperatures of 1400-1520°F. (Tube temperature approximately: 1800°F.)

There are reasons for this performance, of course. For the properties of Inconel alloy include excel-

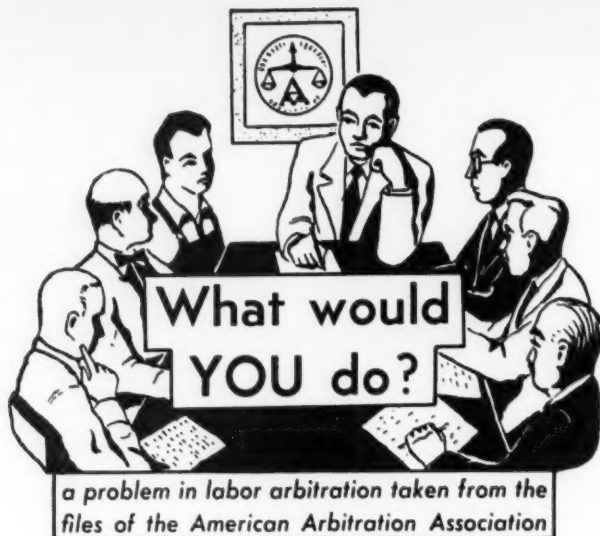
lent high temperature strength . . . high resistance to corrosion by combustion gases . . . and ability to withstand thermal shock and attack by many types of heat treating atmospheres. (Inconel alloy is readily fabricated and welded, too!)

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INCO NICKEL ALLOYS



The Case of the Tippler

Pete K. knew he was violating a company rule when he hid behind some packing cases for a quick drink out of a bottle he had brought into the shop, but he thought no one would notice. Unfortunately for him, the foreman caught him red-handed and sent him home for the rest of the week, which amounted to a disciplinary suspension of three and a fraction days.

During the time he was out, the personnel manager reviewed the case and decided the foreman had been too easy on Pete. "This isn't the first time he's pulled a stunt like that," he said. "When Pete shows up for work Monday, tell him he's fired."

The foreman did as he was told and the union filed a grievance. "You can't punish a man twice for the same offense," said the union business agent. "You gave Pete a disciplinary layoff for a few days. Anything you add to that amounts to 'double jeopardy'."

Eventually, the case went to arbitration.

What Would YOU Do?

THE AWARD:

The arbitrator acknowledged that according to the company rules and past practice, Pete could have been fired on the spot. But he wasn't fired. He was only suspended. Under the circumstances the union's claim of "double jeopardy" was correct. It would have made all the difference in the world, the arbitrator said, if the foreman had sent Pete home *pending a final decision in his case*. That would have made the personnel manager's decision valid. As it was, Pete was reinstated with back pay from the Monday following his layoff.

The Case of the Scheduled Holiday

Under a union contract, July 4 was to be a holiday

for which employees would be paid without working. If the company did schedule work, double time would be paid. There was a proviso, however, which said that if any employee failed to show up on a scheduled holiday and didn't have a justifiable excuse, he would not only lose the double time, but he wouldn't get the holiday pay either.

On July 1 management announced that work would be scheduled on Independence Day. Phil B. already had some plans for the weekend, so without saying anything to the foreman, he stayed out. Naturally, he took it for granted he wouldn't get any holiday pay. But he was surprised to discover that in addition to that loss, he got a two-day suspension.

"To deliberately stay out when you were expected to work is a violation of company rules," said the foreman. "The company has the right to discipline you for it."

Phil filed a grievance. When it came to arbitration the union argued that a man has a right to stay out on a holiday if he wants to, and the loss of pay was the only penalty that could be invoked.

What Would YOU Do?

THE AWARD:

The arbitrator's analysis of the contract showed that if a man stayed out on a holiday with a *good* excuse, he'd get holiday pay. If his excuse was not justifiable, he'd lose the pay. Since this penalty was written right into the contract, the company didn't have the right to add to it. Phil was admittedly in the wrong in disregarding the scheduled work, but all the company could do was deprive him of holiday pay. The suspension was revoked.

CAUTION:

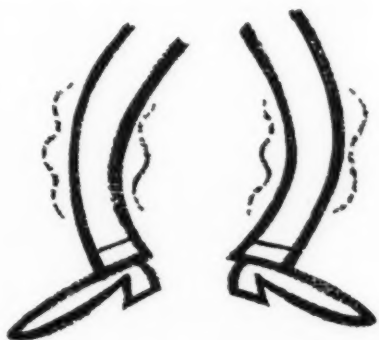
The awards in these cases are not an indication of how other arbitrators might rule in other apparently similar cases.



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Later—Discoloration of finished parts apparent. rejects more frequent, pickling necessary . . .



Still later—Oil! Pressure regulators clogged, catalyst poisoned, incomplete dissociation . . .



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HEAT TREATING HINTS

Which Should You Ask For— Normalizing, Annealing, or Stress Relieving?

By A. S. EVES

Perfection Tool and Metal Heat Treating Co., Chicago, Illinois
"I asked for bread, and he gave me a stone!"

That could well be the plaintive wail of a customer who has asked his heat treater to normalize some steel and then finds when it comes home that it is much too hard to machine. Maybe the next time he requests an anneal and then much to his surprise, instead of machining properly, the metal will tear!

Now it would seem a simple matter to explain to this gentleman that the terms "normalize," "anneal," and "stress relieve" are not interchangeable even though a lot of folks seem to think so. The processes are not all the same; their very names indicate something of the differences.

However, all three processes do have some things in common. While their prime purposes differ, their benefits tend to overlap, and this perhaps accounts for much of the confusion and misuse of these terms. A closer look at what each process is best fitted for may do more for the reader than merely to earn the respect of his heat treater; it may also avoid future trouble and enable him to get more for his heat treating dollar.

At the outset it is well to understand that these processes offer not just one but a variety of desirable results. Each has features that can be aimed at particular shop problems. The right choice of treatment is always a help. Also it should be remembered that these, like all heat treating techniques, must be varied a little in time and temperature to suit the particular metals being treated.

Comparisons

Briefly, the main purpose of "normalizing" a metal is to bring it back to normal. That of "annealing," of course, is to soften. The term "stress relieving" tells its own story. However, to compare all three, let us take a look at the temperatures and techniques that are used.

Heating

Normalizing is a form of treatment in which steel is heated to about 100°F. above the "critical range." That is the very important stage where "austenite"—the stuff that makes hardening possible—is formed. Catalogs of steel manufacturers usually show the recommended temperatures for normalizing each type.

Annealing, however, (with one exception touched

on later) requires that the heating cease when it is at or near the critical.

In stress relieving, although the temperatures used may vary from 212°F. (boiling water) to about 1100°F., they are always kept well below the critical range.

These three entirely different heat ranges for the three processes are important differences, but they are not the only ones; they also differ in manner and rate of cooling.

Cooling

In normalizing, after the material is heated through, it usually is removed from the furnace and allowed to cool in still air at ordinary room temperature.

Annealing, on the other hand, is cooled more slowly, often at a specified rate and usually in the furnace. Relative cooling rates are as follows:

Fast furnace cool	300°F. per hour
Slow furnace cool	50°F. per hour
Very slow cool	20°F. per hour

In the case of stress relieving, however, it is not necessary to be concerned about the rate or manner of cooling, since the temperatures used are below the critical.

But woe to the man who thinks of either normalizing or annealing as a mere stress relieving operation. He may wind up with a far different condition in his tools or parts than he expected; or he may miss some very good bets.

After all, it's up to the customer to know the purpose and something of the method involved in any treatment he specifies.

Purposes and Results

Normalizing is intended to produce a very desirable homogeneous structure, which simply means it will then be uniform throughout. It is often done between the operations of forging steel and of annealing it, or after rolling, hot-forming, etc., to restore the grains to their proper size. The material will be all the tougher for this. Besides, normalizing also relieves stresses caused by such operations. Also it can help the hardener to turn out a more uniform hardening job. For many steels, normalizing serves the same purpose as preheating—indeed it sometimes proves even more effective.

Unlike annealing, this operation is practically never done on pieces that have previously been hardened. Instead, where normalizing can be used to advantage, an annealing operation usually follows. However, note carefully! A steel that is air-cooled from a temperature above its critical is very likely to harden up somewhat. That is, it will tend to self-harden. The degree of hardness will be in accord with its composition or make-up; but on cooling, it may prove to be too hard to cut.

Contrariwise, normalizing may be just the right process for certain alloys because it leaves them harder than they originally were, higher in tensile

strength, and relatively free from internal stresses caused by any previous working.

Steels that are designed especially for air-hardening (high speed, and high carbon high chrome types), are not good subjects for normalizing. As for forgings, while the stresses of normalizing are less severe than those of forging, immediately after a forging is normalized it should be given an anneal. (Remove any decarburized surface before doing either).

Annealing

Annealing takes several forms and accomplishes many things, but its primary purpose is to *soften*. Another feature is that it is often used on metals other than steel, such as brass.

It can help toward easier machining, cold-working, forming, etc. Very frequently the metal used is so hard no such work could be done without it. Forged tools which are to be machined or ground must first be annealed, and some hardened tools have to be re-hardened.

Annealing improves or restores ductility. It helps to refine the grain when it has been coarsened by some previous heating. And it aids in getting rid of residual strains due to rolling, forging, cold drawing, straightening, forming, etc. Also, it can alter the electric, magnetic, or other physical properties of the metal, and it removes gases.

All annealing involves the control of both heating and cooling. Non-uniform heating in this process can result in poor grain structure. Steels should be heated slowly and throughout their heaviest sections.

Also, because the rate of cooling is much slower than air cooling, annealed pieces are much softer than the same steels when normalized. A "full anneal" after heating to the critical and furnace cooling gives the maximum softness and grain refinement.

Earlier it was mentioned that there was an exception to the rule that heating when done for annealing

should not be allowed to exceed the critical temperature of the metal. In "cycle annealing," however, to produce a definite grain structure or to treat steels that are particularly sluggish, a sort of over-and-under the critical anneal is given; that is, they are put through a cycle of heats, back and forth, above and below the hardening range.

Also "quick annealing" can be done by heating steel beyond the critical and then burying it in some dry material such as powdered mica. This cooling is faster; however, the material is less uniform than when cooled in a furnace and it doesn't give quite as good all-round results.

Another method recognizes the fact that soft steel is not necessarily best for machining. It won't cut well if it is too soft and it may simply tear. Better for such steels is an annealing technique called "spheroidizing" which is a prolonged "soaking" of bars, forgings, castings, or tools at about 50°F. below the critical, approximately 1380 to 1480°F. The aim is to produce a *globular* microstructure in the steel, excellent for cold forming, heat treating, milling, drilling and some turning operations. Steels that are above .90 in carbon are freer cutting after spheroidizing, and they develop their best properties if it is done before hardening. The process can be speeded somewhat by oil quenching after a thorough soak at 1500 to 1600°F. or air cooling from 1600 to 1650°F.; but this should be followed at once by annealing at 1400°F.

Special forms of annealing are also used in the wire industry. One is known as "process" annealing, and is done at 1020 to 1200°F. This industry also does what they call "patenting" at 800 to 1050°F. and which involves cooling in air or in a bath of molten lead or nitrides.

(Continued on page 34)

Sound Familiar?



ABSTRACTS

MEASURING QUENCHING SPEED

by

E. A. Bender and H. J. Gilliland
Process Development Section
General Motors Corp.
Detroit

A basic requirement in the heat treatment of steel is the extraction of heat from the metal in such a way as to obtain the desired physical properties.

The problem of getting the right quenching rate to meet specifications of the many steels used in industry has plagued heat treaters for years. Recognizing the need for a method to compare accurately the heat extraction properties of numerous quenching media, the Process Development Section of General Motors Corp. devised the magnetic quench test.

The test takes advantage of a property: metals lose their magnetism when they are heated above a certain temperature (known as the Curie point), and regain it when cooled below this temperature. Any magnetic material could be used; in the preliminary work, several steels were investigated.

Pure nickel was chosen for repeated testing because of its non-scaling characteristics and its resistance to cracking when repeatedly heated and quenched. A spherical shape with a diameter of 7/8" and weighing about 50 grams was selected for the test.

The nickel ball was heated to 1600°F. in either an air or controlled atmosphere furnace. After uniformity of heat was attained, it was quenched in a magnetic field surrounding the quench sample under test. The time required for the ball to cool from 1600°F. to the Curie point of nickel (at which instant it is attracted by the magnet) is a measure of the heat extraction power of the quenchant.

(The Curie point of pure nickel is 670°F. It is below the nose of

the S curve in the isothermal transformation for most steels).

To evaluate the method, six premium oils, two straight mineral oils, and straight mineral oils with special proprietary additives were used as samples. The oils were evaluated by measuring the time required for the standard nickel ball to regain its magnetism. This gave a direct comparison of quenching rates: the faster the oil, the shorter the time required for the nickel to regain its magnetism.

Results are given in the following table:

TEST OIL	QUENCH RATE (Seconds)
Group A	
Oil E	9.8
Oil A	10.0
Oil C	10.2
Group B	
Oil B	11.2
Oil F	12.2
Oil D	14.4
Group C	
Oil S-7	17.8
Oil S-9	19.6

The premium oils are identified by symbols, A through F; the straight mineral oils by their designations, S-7 and S-9.

The results were established by several hundred repetitive tests in still oil (200 cc) at room temperature. Relative quenching speeds were substantiated by agitation up to 300 feet per minute and under heat at 130°F.

The test was also used to study the effect of proprietary additives in straight mineral oil. The influence of varying percentages of a single additive on the quenching power of S-9 oil was studied. Additions in excess of 8.1 per cent of the proprietary compound did not increase the quench speed of the oil, except when a second compound was introduced. But the ultimate quenching speed did not equal that of the best premium oils.

(At the time of these tests, experiments were also made with a 40-gram nickel sphere and 180 cc of quenching oil. The conclusion: In comparing oils, results are relative so long as the nickel ball and oil sample remain constant).

Because of the importance of correlating test results with shop practice, a series of transverse hardness tests were made on SAE 1046 steel quenched in various oil samples. The test bars were 7/8" in diameter, 3" long, and had two surfaces 180 degrees apart. They were ground flat before heat treatment to get accurate surface hardness measurements.

The test pieces were austenitized at 1500°F. in an electric furnace having an atmosphere of endothermic gas. Quenching was done in 2 liters of still and agitated oil, with an oil velocity of about 120 feet per minute.

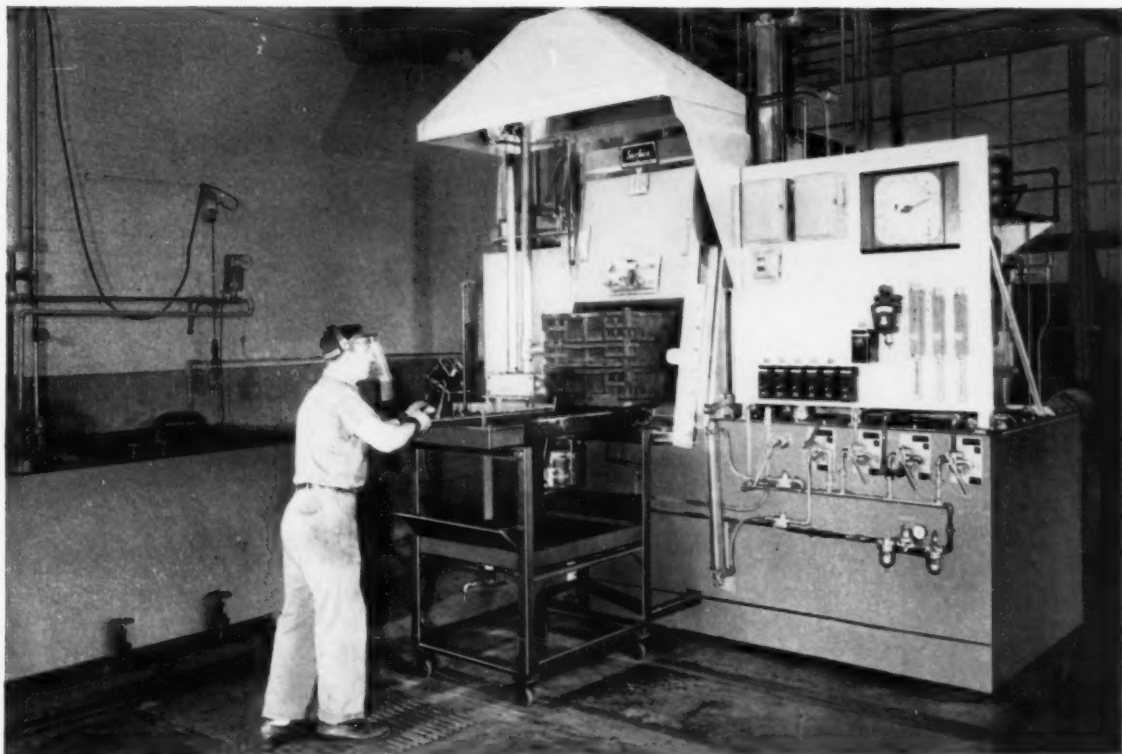
Each bar was sectioned, and transverse hardness checks were made. The correlation between the magnetic test and the transverse hardness tests was excellent.

The magnetic quench test was also compared with two commercial test procedures used in industry. After exhaustive study, the conclusions involving the competitive processes were that the results did not coincide with transverse hardness tests; they were not reproducible; and one competitive test was difficult to perform, requiring two operators.

The original equipment for the magnetic quench test consisted of a horseshoe magnet, a 250 cc beaker, a stop watch, and a hanger supported across a rod. An electrical device was later developed to simplify the method and eliminate human error in repeated testing. (This apparatus was demonstrated by E. F. Houghton & Co. at the Metal Show in Chicago).

(Continued on page 20)

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ABSTRACTS

(Continued from page 18)

A portable device (consisting of a single coil, a balanced bridge network, an amplifier, and an electric timer) is now being tested for use in production quenching systems.

The system is not limited to quench tests of oils. It may be used to evaluate the extraction rates of heat from gases and salts, to study the inhibiting effects of sludge buildup, to examine the effects of surface condition of heat treated parts on quenching, and to evaluate the inhibiting effect of salts adhering to the piece during quenching.

Source—STEEL, December 30, 1957

ELECTRIC FURNACES FOR CARBURISING AND HEAT TREATMENT

Review of Modern Practice in Germany

Source—Metal Treatment and Drop Forging

Changes in heat-treatment practice in the last few years have been due on the one hand to the development of gas generation plants and furnaces with controlled atmospheres and, on the other hand, to the widespread introduction of continuous furnaces, especially those with automatic control. It is nowadays possible by the use of a suitable gas to obtain any desired atmosphere, be it for limiting decarburisation, for enhancing carburisation, for decarburisation, for straight hardening, white annealing or for annealing in a reducing atmosphere. The development of plants for the generation of particular furnace atmospheres led naturally to the development of furnaces suitable for their use.

Carburising and Carbo-Nitriding Processes

For the carburisation of case hardening steel the gaseous carburising process, which has long been established in America, has been widely adapted, employing natural gases, town's gas or liquid hydrocarbons. The most widely employed

furnace in Germany today is the shaft furnace (pit furnace or retort furnace) with gas circulation according to a system developed by Brown-Boveri known as 'BBC-Grünwald.' In this type of furnace a number of different carburising operations may be carried out.

Large hardening installations, with several furnaces which may be used for other operations besides carburising, such as white annealing or scale-free hardening under controlled atmosphere, will make use of a carburising gas generated in a special unit from lighting gas, propane, or producer gas. The generator gas will have a CO-content of 12-30% according to requirements and the manner in which the generator is operated. The employment of a special carburising gas has the advantage that the control of the case depth is simpler and easier to observe. Hardening plants with few furnaces and with no specially large furnaces and working to case depths of under 1.5 mm., and which do not require protective atmospheres for any other purposes, can dispense with a special gas-generating unit and can make do with a furnace atmosphere formed from a mixture of propane, ammonia and air. The gas requirements may be met from a battery of bottles.

'Homocarb' Method

A third carburising process is the 'Homocarb' method which has been introduced from America, in which the carburising agent is a liquid hydrocarbon (a benzol-alcohol mixture) which is introduced dropwise into the furnace and volatilised. The same type of pit furnace is equally suitable for this method of hardening, but may become uneconomic when applied to the larger type of furnace.

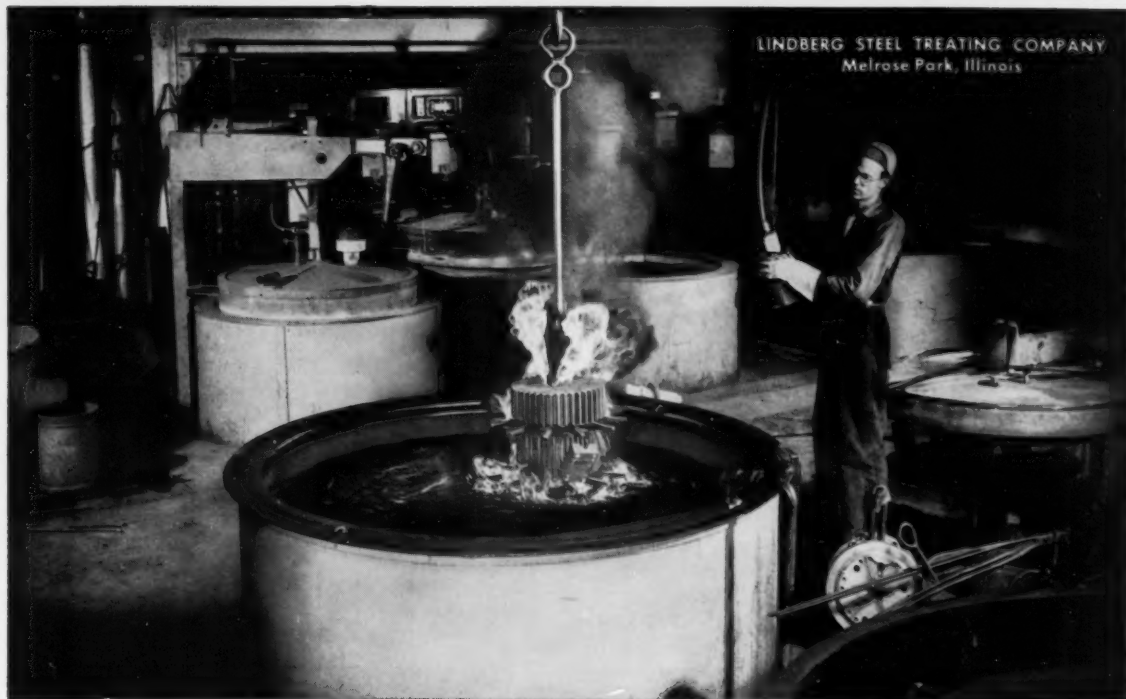
Pit furnaces of this type used for both carburising and carbo-nitriding are well insulated by being set into the floor and are heated by electrical elements. According to the size of the furnace, the heating is carried out by a number of consecutive groups of elements which are automatically regulated. The

cover of the carburising chamber can be lifted either by a crane hook or by means of an oil-hydraulic mechanism and swung aside. The gas-circulating mechanism is incorporated in the cover, including a water-cooled heat-resisting duct and fan which ensures an even circulation of carburising gas throughout the chamber. The pressure inside the carburising chamber is maintained at about 250 mm. w.g. to prevent ingress of air and to force the gas into all corners and crevices of the charge. The pit cover is secured against the carburising chamber by means of a gas-tight rubber seal. In cases where the furnace charge is not to be hardened directly after carburisation but is to be cooled more or less slowly in the pit, then the sealed chamber can be lifted from the furnace by the crane and put into a cooling pit which is connected either to a central air-circulating system or directly to its own fan. The carburised items inside the chamber remain during the cooling period 3 to 6 h. or more, under pressure of the carburising gas.

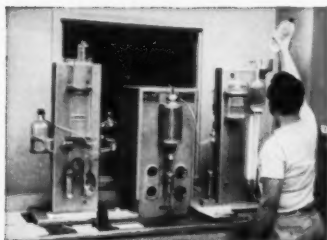
The furnace charge may be arranged in the chamber in a number of ways. It may either be built up in a series of layers from the bottom or be suspended on a series of supports hanging from the top. A typical cluster of small items will have an outside diameter of about 750 mm. and a height of about 900 mm. and will contain between 400 and 600 kg. weight of machine parts. According to size and shape, between two and eight layers of charge may be built up in this way.

The introduction of this form of pit furnace into the hardening shop has brought about considerable economies in carburising time, carburising agents, power consumption and labour costs. The actual cost of gaseous carburising will vary considerably according to furnace size, charge weight and depth of case. In general for a case depth of 1mm. the cost is from 33 to 50% less than the cost of carry-

(Continued on page 38)



For machine shop tolerances— Lindberg uses Cities Service Quenching Oil



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SURFACE HARDENING PRACTICES

Part IV

By **E. J. PAVESIC**,
Director of Research
Lindberg Steel Treating Company
Melrose Park, Illinois

Editor's Note: This is the conclusion of the article and is a definition of terms used in the three preceding parts.

Glossary of Terms

Austenitizing — Forming austenite by heating a ferrous alloy into the transformation range (partial austenitizing) or above the transformation range (complete austenitizing).

Blank carburizing — Simulating the carburizing operation without introducing carbon. This is usually accomplished by using an inert material in place of the carburizing agent, or by applying a suitable protective coating to the ferrous alloy.

Blank nitriding — Simulating the nitriding operation without introducing nitrogen. This is usually accomplished by using an inert material in place of the nitriding agent, or by applying a suitable protective coating to the ferrous alloy.

Carbonitriding — Introducing carbon and nitrogen into ferrous alloy by holding above AC1 in an atmosphere that contains suitable gases such as hydrocarbons, carbon monoxide, and ammonia. The carbonitrided alloy is usually quench hardened.

Carburizing — Introducing carbon into a solid ferrous alloy by holding above AC1 in contact with a suitable carbonaceous material. The carburizing alloy is usually quench hardened.

Case — In a ferrous alloy, the outer portion that has been made harder than the inner portion or core by case hardening.

Case hardening — Hardening a ferrous alloy so that the outer portion or case is made substantially harder than the inner portion or core. Typical processes used for case hardening are carburizing, cyaniding, carbonitriding, nitriding, induction hardening, and flame hardening.

Cementation — The introduction of one or more elements into the outer portion of a metal object by means of diffusion at high temperature.

Core — In a ferrous alloy, the inner portion that is softer than the outer portion or case.

Cyaniding — Introducing carbon and nitrogen into a solid ferrous alloy by holding above AC1 in contact with molten cyanide of suitable composition. The cyanided alloy is usually quench hardened.

Decarburization — The loss of carbon from the surface of a ferrous alloy as a result of heating in a medium that reacts with the carbon.

Differential heating — Heating that produces a temperature distribution within an object in such a way that, after cooling, various parts have different properties as desired.

Direct quenching — Quenching carburized parts directly from the carburizing operation.

Drawing — A misnomer for tempering.

Flame annealing — Annealing in which the heat is applied directly by a flame.

Flame hardening — Quench hardening in which the heat is applied directly by a flame.

Fog quenching — Quenching in a fine vapor or mist.

Gas cyaniding — A misnomer for carbonitriding.

Hardening — Increasing the hardness by suitable treatment, usually involving heating and cooling. When applicable, the following more specific terms should be used:

Age hardening, case hardening, flame hardening, induction hardening, precipitation hardening and quench hardening.

Heat treatment — Heating and cooling a solid metal or alloy in such a way as to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this definition.

Hot quenching — Quenching in a medium at an elevated temperature.

Induction hardening — Quench hardening in which the heat is generated by electrical induction.

Induction heating — Heating by electrical induction.

Interrupted quenching — Quenching in which the metal object being quenched is removed from the quenching medium while the object is at a temperature substantially higher than that of the quenching medium. See also "time quenching".

Martempering — Quenching an austenitized ferrous alloy in a medium at a temperature in the upper part of the martensite range, or slightly above that range, and holding in the medium until the temperature throughout the alloy is substantially uniform. The alloy is then allowed to cool in air through the martensite range.

Nitriding — Introducing nitrogen into a solid ferrous alloy by holding at a suitable temperature (below AC1 for ferritic steels) in contact with a nitrogenous material, usually ammonia or molten cyanide of appropriate composition. Quenching is not required to produce a hard case.

Preheating—Heating before some further thermal or mechanical treatment. For tool steel, heating to an intermediate temperature immediately before final austenitizing. For some non-ferrous alloys, heating in order to homogenize the structure before working.

Pseudocarburing—See "blank carburizing".

Pseudonitriding—See "blank nitriding".

Quench hardening—Hardening a ferrous alloy by austenitizing and then cooling rapidly enough so that some or all of the austenite transforms to martensite. The austenitizing temperature for hypoeutectoid steels is usually above AC3 and for hyper-eutectoid steels is usually between AC1 and AC cm.

Quenching—Rapid cooling. When applicable, the following more specific terms should be used: Direct quenching, fog quenching, hot quenching, interrupted quenching, selective quenching, spray quenching and time quenching.

Selective heating — Heating only certain portions of an object so that they have the desired properties after cooling.

Selecting quenching — Quenching only certain portions of an object.

Spray quenching—Quenching in a spray of liquid.

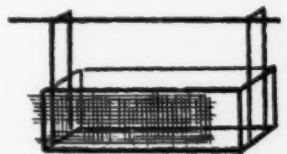
Tempering—Reheating a quench-hardened or normalized ferrous alloy to a temperature below the transformation range and then cooling at any desired rate.

Time quenching — Interrupted quenching in which the duration of holding in the quenching medium is controlled.

These definitions were prepared by the joint Committee on Definitions of Terms Relating to Heat-Treatment appointed by the American Society for Testing Materials, the American Society for Metals, the American Foundrymen's Association, and the Society of Automotive Engineers. Last revision, June 1955. • • •

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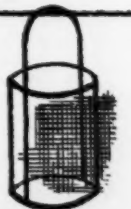
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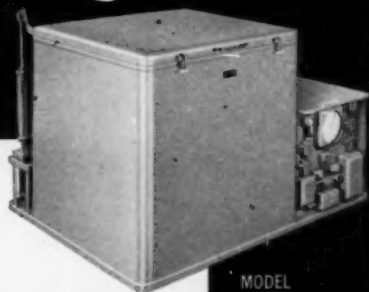


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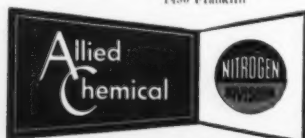
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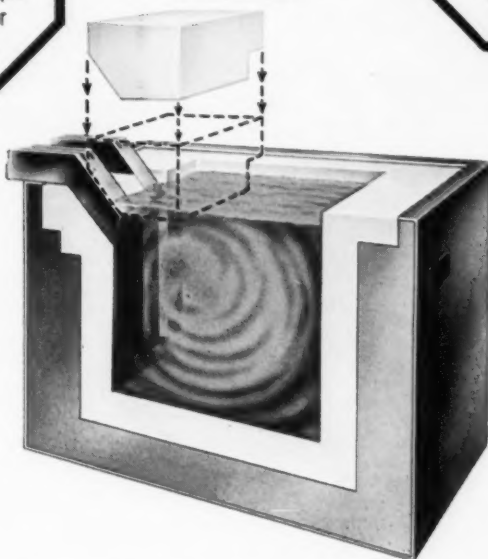
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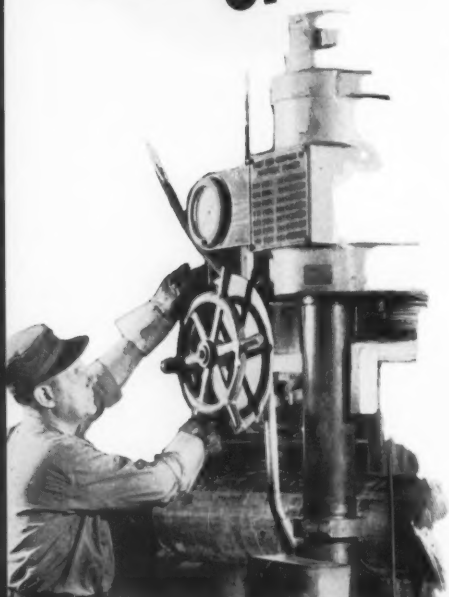
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Ace Metal Treating Corp.
611 Grove St., Elizabeth 2
American Metal Treatment Co.
Highway 25 & LaFayette St., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Owego Heat Treat, Inc.
Rural Route 1, Apalachin
Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E. Rochester 5
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 11
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Robert Wooler
Limekiln Pike, Dresher
J. W. Rex Co.
834 West 3rd St., Lansdale
Drever Company
220 West Cambria St., Philadelphia 33
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
4272 Wissahickon Ave., Philadelphia 32
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 1686, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
830 S. 5th St., P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

METAL TREATING INSTITUTE

271 NORTH AVENUE, NEW ROCHELLE, N. Y.

**"QUENCHOL®
increased
surface hardness
to 60-62"**



Mr. R. V. White



A large Mid-Western automotive transmission manufacturer was experiencing a costly problem: Spotty hardness in the machining of gears was causing reruns, rejects and scrap.

On a routine call, R. V. White, Sinclair Industrial Representative, was asked to help.

Mr. White reports: "The surface hardness requirements were 58-60 Rc, and were running only from 55-59 Rc. Based on previous experience, I recommended tests with Sinclair QUENCHOL® 524.

EXCEEDED EXPECTATIONS Mr. White continues: "QUENCHOL 524 increased the surface hardness to 60-62. Moreover, core hardness was increased from a minimum of 26 Rc to 30 Rc.

"The company changed immediately to Sinclair QUENCHOL in several small quenching units, and is presently preparing two 2000-gallon continuous units which will be filled with QUENCHOL 524."

If you have a problem with cutting oils and coolants, it will pay you to look into the advantages of Sinclair QUENCHOL 524. Contact your local Sinclair Representative, or write to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR
CUTTING OILS AND COOLANTS



Dino, the Sinclair Dinosaur, says:

"Contact your Sinclair Representative now."

MTI *Activities*



REPORT ON COMMERCIAL HEAT TREATING

The year 1957 saw further expansion and improvements in plants and equipment in the field of commercial heat treating.

Through the years the commercial heat treater has been a leader in the development of new and improved methods for heat treating metals, and the modern commercial heat treating plant of today boasts the finest and most up-to-date equipment. Never in its history has the industry been in such an excellent position to meet the ever-increasing demands placed upon it.

There have been substantial increases recently in the volume of nitriding and in the demand for induction heating of large members. It is significant that both processes reduce distortion with improved surface fatigue properties. Nitriding and induction facilities have been added in commercial plants including two and three station motor generator sets with large scanning equipment.

Considerable attention is being directed to methods for reducing time and cost of carburizing. Higher temperature carburizing (1700°F.) is being evaluated. High frequency induction heating in the presence of carburizing gases for shallow case depth is being explored. Controlled carbon concentration plus carbon restoration is becoming routine in most commercial heat treating plants.

K. U. Jenks, *President*
Metal Treating Institute

MEMBER ADDRESSES ASM

Recently Mr. Horace C. Knerr, President of Metlab Company, Philadelphia, Pennsylvania, and a Past President of the MTI, was

the featured speaker before the dinner meeting of the Porir, Illinois, Chapter of the American Society for Metals. The subject of his lecture was "Metallurgical and Production Aspects of Nitriding."

CHIEF METALLURGIST

Lucas S. Miel, President of Commercial Steel Treating Corporation, Detroit, has announced the appointment of Michael Soviak as Chief Metallurgist in charge of the company's metallurgical control programs.

Soviak, who has served as assistant to Chief Metallurgist, Jack Fraser, since 1946, is a graduate of the Henry Ford Trade School, the Ford Mechanical and Metallurgical Apprentice Schools and the Lawrence Institute of Technology.



According to Mr. Miel, Soviak will head the company's staff of six full time metallurgists, and Jack Fraser will become his assistant in a counseling capacity.

REGIONAL MEETING OF EAST COAST MEMBERS

Eighteen member companies of the Metal Treating Institute sent delegates to attend a Regional

Meeting of the Atlantic Coast Chapter of the MTI, held at the Hotel Lexington in New York City on Friday, January 17th.

Twenty-four delegates attended the all-day session which was highlighted by the lectures of two excellent speakers:

1. Mr. H. M. Webber of Harper Electric Furnace Company, Buffalo, New York, delivered an illustrated lecture on "Latest Developments in Furnace Brazing."
2. Mr. William F. Ross of Ipsen Industries, Inc., Rockford, Illinois, lectured on "The Preparation and Control of Atmospheres for Gas Carburizing and Carbonitriding."

After luncheon and the completion of the lectures, plans were discussed for the next meeting of the Chapter, which will be held on Friday, June 20th, in Philadelphia. Part of this next program will be a visitation to the Metlab Company upon the gracious invitation of Horace C. Knerr.

During the business session of the meeting Mr. Michael Kober was nominated for President and Mr. William E. Engelhard for Vice President. These nominations were accepted by the members present, and Messrs. Kober and Engelhard were unanimously elected.

John O. Hulting

It is with deep regret that we announce the sudden passing in Florida of member John O. Hulting. President of Perfection Tool & Metal Heat Treating Co., Chicago, Illinois, on Saturday, December 14th.

NEWS TO HEAT TREATERS...

FLAME HARDENING FACILITIES

New induction and flame hardening facilities have been completed by the Massachusetts Steel Treating Corporation, Worcester, Mass.

Housed in a new, specially designed building, the new facilities include a 50-kilowatt General Electric electronic induction heater, believed to be the largest of its type in New England. Capable of progressive hardening work with diameters up to 4 inches and lengths to 42 inches, the unit provides automatically controlled heating and quenching cycles for treating the entire length or any desired portion of the work in one pass.

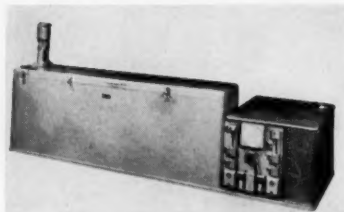
Flame hardening equipment includes new, fully-manifolded sources of oxygen and acetylene, assuring adequate gas feeding at all times to any single unit or battery of flame hardening units.

For further information circle No. 1



STAINLESS STEEL HARDENING

A new low-temperature chilling machine, which is said to surpass conventional high-temperature



methods in the hardening of stainless steel, has been developed by Cincinnati Sub-Zero Products, Cincinnati, Ohio. The new unit helps to eliminate many of the problems which occur in the conventional heat treatment of stainless steel, yet obtains the best properties of stainless through the new method of sub-zero quenching.

The machine is not only efficient for stainless steel hardening, but is

also suited for use in any type of production chilling operation. The built-in system of wide range temperature adjustment and quick pull-down from $+180^{\circ}$ to -120° F. offers the versatility demanded by modern industry.

For further information circle No. 2

INDUCTION HEATING

A self-contained, two-station work table designed with complete flexibility to perform hardening, brazing, annealing and soft soldering operations has been introduced by Welduction Corporation, Detroit, Mich. Standard units are



equipped with 220/440 V. 3-phase motor generators available in ratings from $7\frac{1}{2}$ to 30 KW. The work table has an output of 220 V., 10 KC, single phase. Unit comes fully equipped for immediate installation.

For further information circle No. 3

DEW-POINT MONITORING SYSTEM

The American Instrument Company announces a new instrument system, the Aminco Dew-Point Monitoring System which records the amount of humidity present in hydrogen coolant for generators and which detects its dew-point because hydrogen-cooled generators tend to break down when excessive amounts of humidity form in the lines.

The system is composed of sensing stations strategically placed

(Continued on page 33)

METAL TREATING



Large Stocks of One-Piece Elements. You get quick deliveries of Norton "Hot Rods" — on short notice. Also, most popular sizes of these CRYSTOLON heating elements — like the sizes shown in this section of the Worcester stockroom — are now made in the new, one-piece construction — with no welds. This assures greater strength and uniform straightness throughout each rod.

Greatly Increased Strength. Ever since they were first produced "Hot Rods" have been endorsed by users for outlasting other non-metallic heating elements up to 3 to 1. Today, the new one-piece rod, made in most popular sizes — and soon available in all sizes — is twice as strong in standard cross-bending tests.



One-piece "HOT RODS" now ready for immediate delivery... famous for long life and economy

CRYSTOLON* heating elements bring you extra advantages for better performance and bigger savings

Straighter Than Ever. Throughout the entire length of a one-piece, non-welded "Hot Rod" there isn't the slightest bulge in the surface. So, when you insert them into the openings of your furnace or kiln you can be sure there'll be no binding due to uneven diameters.

Scientifically Safe Packaging protects "Hot Rods" even more thoroughly than delicate household glassware or china. They're packed shockproof to reach you unbroken.

"Hot Rods" are a typical Norton R — an expertly engineered prescription for greater efficiency and economy in electric furnaces and kilns. Made of self-bonded silicon carbide,

each rod has a central hot zone and cold ends. Most popular sizes are non-welded and interchangeable with your present rods.

You save in element costs because you use far less "Hot Rods." Also, their more uniform heating quality, due to their slow, evenly matched rate of resistance increase, helps you protect product quality and maintain a smooth production flow. For further facts on "Hot Rod" advantages send for booklet *Norton Heating Elements*, NORTON COMPANY, Refractories Division, 620 New Bond St., Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRATORIES

Engineered... **R**... Prescribed

*Making better products...
to make your products better*

NORTON PRODUCTS
Abrasives • Grinding Wheels
Grinding Machines • Refractories
BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones
Pressure-Sensitive Tapes



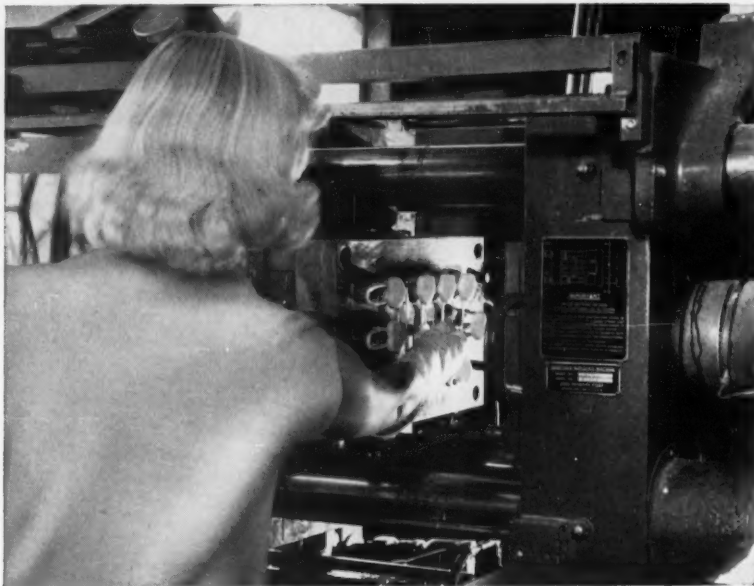
Tool Steel Topics



On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corporation



Lustre-Die Takes High Polish For Molding Plastic Rattles

Shreve Molded Products, Youngstown, Ohio, needed an injection mold for the production of heart-shaped parts for baby rattles, using acetate and styrene plastics. They wanted a mold capable of taking a high polish, so as to produce unusually attractive parts. In addition, the mold had to have the stamina to perform economically during long production runs.

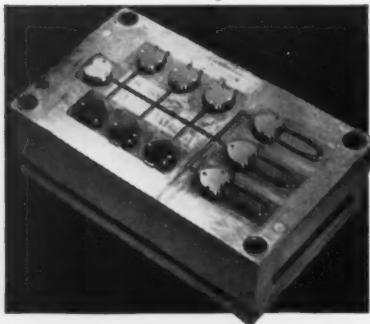
The problem was put up to Leed Steel Co., Buffalo, N. Y., Bethlehem's local tool

steel distributor. Their recommendation was Lustre-Die tool steel. It proved to be an excellent choice, too, for the mold, which was produced by Tri-Penn Tool Co., Erie, Pa., has been satisfactory in every way.

Lustre-Die is ideal tool steel for producing plastic parts because its properties enable it to take an unbelievably bright, mirror-like polish. Not only does Lustre-Die have the proper basic analysis for working with plastics—we even go a step beyond that by adding alloy fortification. We also build up the steel's excellent properties by oil-quenching and tempering, so that it can be furnished ready for machining and polishing.

Lustre-Die is made in the electric furnace, and is carefully inspected to insure cleanliness. It has a minimum of inclusion-causing additions. Besides, modern inspection methods hold injurious porosity to the minimum.

If you have any questions about Lustre-Die, or if you would like to give it a trial run, your Bethlehem tool steel distributor will be pleased to assist you.



BETHLEHEM TOOL STEEL ENGINEER SAYS:

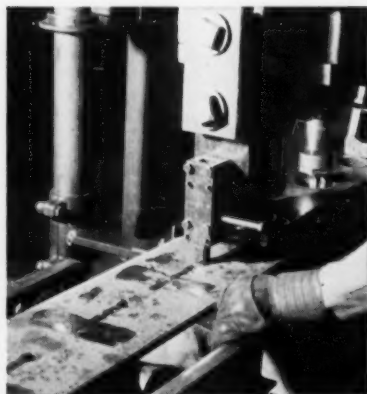


It Pays to Keep Tools Sharp

In many shops, resharpening of production cutting tools is sadly neglected. In an effort to keep output high, too many tools are kept in use beyond the point where the cutting edges become excessively dull.

What happens when edges are dull? The dull edges cause an increase in the service load of the shearing or cutting operation. If the dullness is carried to extremes, tools break. Dull edges also produce rough surfaces on the parts, which may lead to rejections due to defects, or because the permissible tolerances have been exceeded.

Should resharpening be delayed too long, it may be impossible to recondition a tool properly, as deep spalls, cracks and gouges cannot be removed. Usually there is an economic balance point where it is best to resharpen, and for each operation this should be determined in advance. Tools should also be inspected regularly, to prevent excessive dulling. Intelligent use of preventive maintenance of cutting edges can work wonders in providing longer tool life and fewer broken tools.



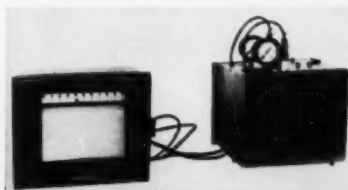
Bearcat Puts Square Holes in 1/2-in. Plate

In this operation, photographed at Frink Sno-Plows, Inc., Clayton, N. Y., Bethlehem Bearcat is putting 11/16-in. square holes in carbon-steel plate, used as cutting edge of snow plows. Though the steel plate is 1/2 in. thick, the average life of each punch is 5500 holes.

NEWS TO HEAT TREATER

(Continued from page 30)

in the hydrogen gas line. These sensing stations continuously sample the moisture content of the hydrogen, and detect its dew-point be-

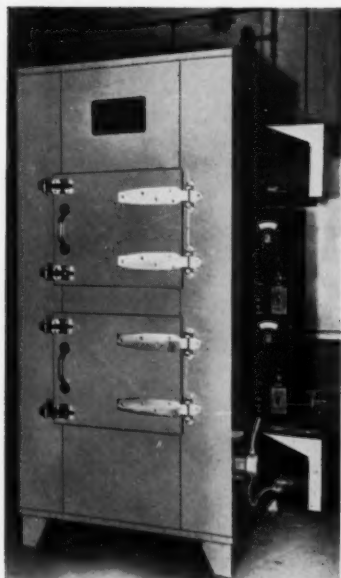


fore and after the hydrogen passes through a drying unit. The dew-point temperature detected by the sensing stations is then transmitted to a recorder. The difference in dew-point before and after the hydrogen coolant has been dried determines the effectiveness of the drier. Should the drier prove to be ineffective, and the humidity of the hydrogen leaving the drier exceed a pre-set safety limit, a relay within the recorder actuates an alarm.

For further information circle No. 4

TWO-CHAMBER OVEN

A new type of oven used for relief of hydrogen embrittlement on plated parts and stress relieving and normalizing of tools, springs, etc., has been introduced by the Grieve-Hendry Co., Inc.



The principal feature of this oven is that it has two chambers,

(Continued on page 35)

JANUARY-FEBRUARY 1958

Trusting your profits to

"pot luck"?



**Switch to pressed steel pots—
eliminate costly sudden failures!**

Occasional severe damage to brickwork, burners, and controls is inevitable with cast steel or alloy pots. Any cast pot may have a concealed flaw — undetectable by visual inspection — which at any one heating may produce a break resulting in major repairs.

Eclipse Pressed Steel Pots cost only one-third as much as cast pots . . . yet cannot turn suddenly defective! No defective steel survives the stresses of drawing. Switch to pressed steel pots and you switch to scheduled pot maintenance that puts your profits on a predictable basis. What's more, Eclipse pots weigh only half as much and have higher thermal conductivity! That means substantial fuel savings and faster, better controlled heating.

Eclipse Pressed Steel Pots are formed from highest quality firebox open-hearth mild steel, from the heart of the ingot, with a perfectly uniform $\frac{3}{8}$ -in. section. They're practically impervious to corrosion. Write for illustrated catalog and price list — 78 standard pots available immediately from stock! For lead, salt, cyanide, oil tempering, metal melting.

ECLIPSE FUEL ENGINEERING CO.

1018 Buchanan Street, Rockford, Illinois

ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD.

20 Upjohn Road, Don Mills, Ontario



INDUSTRIAL
COMBUSTION
DIVISION

HEAT TREATING HINTS

(Continued from page 17)

Another special form is "blue annealing" which is done by certain steel mills. They allow heavy sheets to cool slowly after the hot rolling; the lighter ones pass singly through an open furnace which is kept at annealing temperature. From the color that the steel takes on, this form of annealing gets its name.

"Isothermal annealing" is so called because the metal is quenched to a certain temperature and held there until there is a desired structural change, or a particular hardness level is reached—or both.

Under the head of annealing is also a process called "austempering", especially since its main objective is not to produce hardness but rather to avoid a good deal of it. In this method, parts with more than .60 carbon are quenched from above the hardening temperature into molten salt baths (600 to 700°F.) and held there long enough so that there is no further possibility of quench cracks. This method results in more toughness than is found in steels hardened and tempered to the same degree of hardness in the ordinary manner.

It may well be pointed out here that combining oxygen with carbon in hot steel results in a loss of some or all of the surface carbon ("decarburization"), and perhaps also in some objectionable scaling. The more oxidizing the conditions within the furnace are, the more of this occurs.

However, the parts can be "box annealed" (that is, packed in sealed containers made of heat resisting material) to exclude the oxygen; or they can be heated in a furnace that has an inert (oxygen-free) atmosphere. Some of the latter furnaces turn out work that can truly be called "bright annealed."

Steel cooled in air, however, as in normalizing, does not offer this possibility of protection. Oxidation is bound to occur unless the metal is given some protective coating which will stand the necessary heating.

Stress Relieving

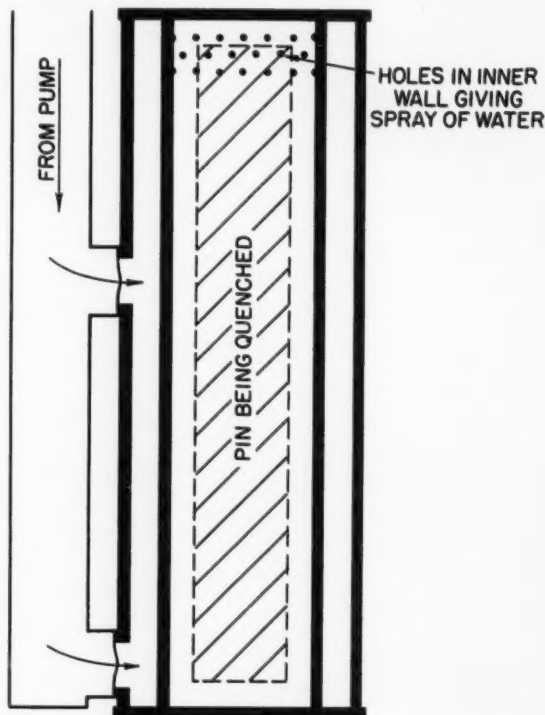
Stress relieving, often called "strain annealing," "strain tempering," or "sub-critical annealing" is almost identical with the tempering operations that are performed by all heat treaters after a quench. In fact, the expression "stress relief draw" is quite commonly used. However, the process can be and is used where there has been no previous hardening.

Pieces that are merely stress relieved are never as soft as those which are full annealed because the temperature is much lower. Nevertheless, this method can be used in many cases to restore the elasticity to steel and to toughen it, or to bring it to a lower hardness reading. Or, as its name implies, stress relieving can reduce residual stresses in metals that have been cast, welded, hobbled, normalized, ground, quenched, or "hogged" in machining.

The moral of all this: Know your treatments, and ask for the one that will cost you the least money and do the best job. • • •

Uniform Hardening

A firm was experiencing difficulty in securing uniform hardening of 3-inch diameter pins. They tried agitated water baths and brine solutions but neither was satisfactory because they got more soft spots than hard ones.



A satisfactory solution to the problem was reached by rigging up a spray quench similar to the one illustrated here in the photograph. The rig consists merely of two tubes placed one inside the other. The inner tube is drilled full of tiny holes and the outer one is connected to a high pressure water pump, thus producing a fine water spray.

This water spray pressure quenching ring resulted in pins having a uniform hardness of 60 Rc.

Source—A. S. EVES
Perfection Tool & Metal Heat Treating Co., Chicago, Ill.

REMEMBER!

MTI SPRING MEETING
Phoenix, Arizona
April 21, 22, 23, 1958

NEWS TO HEAT TREATERS

(Continued from page 33)

each operating independently and having individual maximum operating temperatures. Electric heating is employed. It can be had with either electric or gas heating equipment.

The ovens are supplied completely assembled, having been previously tested and adjusted by the manufacturer and ready for operation. They require only connection of the service at the site. Operation meets Military and Aircraft specifications.

For further information circle No. 5

LOW COST FIRE SYSTEM

A compact, low-cost, automatic, dry chemical fire extinguishing system for flammable liquid, electrical and textile fire hazards has been developed by Ansul Chemical Company of Marinette, Wisconsin.



Intended primarily for protection of moderately-sized hazards such as paint spray and dip operations, small transformer vaults, heat treating and oil quench operations, ovens, overhead cranes, stationary engines and textile lint, the system can be operated auto-

matically or manually.

It consists of a 30-pound capacity dry chemical unit installed near the hazard and serves as a storage tank for the dry chemical. A special CO₂ gas pressure cartridge furnishes pressure to expel the dry chemical onto the fire through piping connecting the dry chemical unit with the hazard area.

For further information circle No. 6

METALLURGY COURSE

The Metals Engineering Institute, a division of the American Society for Metals, announces that the first in a series of 39 home-study and in-plant training courses is now available to both individuals and industry.

"Elements of Metallurgy" begins with a study of the structure and properties of metals, discusses chemical reactions of metals, and pays special attention to smelting, refractories, refining, and electrolytic processes. Physical aspects of solidification, heat treatment, precipitation hardening, diffusion and surface treatments, and methods of testing round out this broad, basic, up-to-the-minute course—of interest to individuals and technical and administrative personnel.

An instructor assigned to each individual, corrects papers, makes helpful comments, and forwards lessons according to a schedule set by the student himself. MEI guidance and special instructional assistance is also available to industrial groups who wish to use the course as an in-plant or on-the-job training program. Framed certificates are awarded to those who successfully complete the 15-lesson course.

For further information circle No. 7

GAS PURIFIERS

Hydrogen produced for industrial use is guaranteed at least 99.5 per cent pure. The remaining .5 per cent represents a very small amount of impurities—usually requiring most precise and delicate instrumentation to detect.

The only impurity that is of operational consequence is the trace

quantity of oxygen. These oxygen traces are normally inherent in the method of gas production.

Where high temperature operations are performed, such as annealing or other heat treating furnace operations, trace quantities of



oxygen have the same detrimental effect as high dewpoint. Extremely pure (oxygen-free) hydrogen is needed here and for various other industrial and laboratory uses.

Oxygen impurities can be removed easily by using a "Hydropure" purifier manufactured by The National Cylinder Gas Company. Basically, these units provide for the catalytic combination of oxygen and hydrogen to form water vapor. This water vapor is then removed by a drying tower before reaching the point of application. The catalytic reaction performed by these units is so complete that approximately 10 parts per million of oxygen impurity remains. Special units can be manufactured so that less than one part per million oxygen impurity remains.

"Hydropure" units are claimed to be rugged and dependable, the result of careful design, quality materials and exacting production control. While in operation they re-

(Continued on page 37)

MODERNIZING?

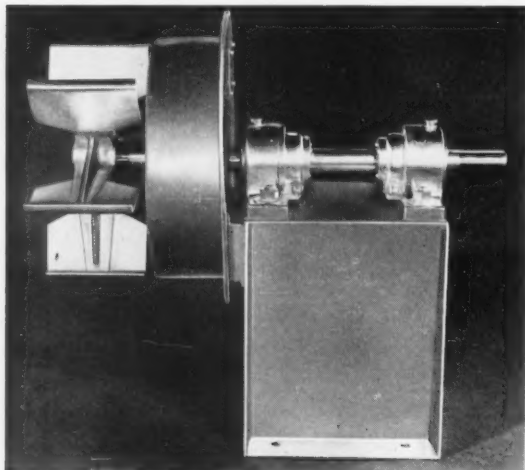
The NEW Forward Curve Radial Blade

CARTRIDGE UNIT BY

GARDEN CITY FAN

(for temperatures up to 1650°)

*cuts costs because it
eliminates duct work*



Cartridge unit can be mounted in any position

- Costs less initially, costs less to install, costs less to maintain! Yet if you want to convert to a standard insulated fan at a future date you can . . . merely by application of housing. This fan has the famous Garden City patented AIR COOLED SHAFT to prolong the life of your bearings. This cartridge unit is for new or existing furnaces or ovens.

V

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for detailed literature

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FAN COMPANY**
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Representatives
in Principal
Cities

• Fans for Industry • Backward Curve • Forward Curve
• Material Handling • Radial Bladed • Small Exhaust

SPRING HEAT TREATING

(Continued from page 3)

that a slight variation in the atmosphere will not cause significant changes in the carbon content of the surface of the hot springs.

The best furnace types for a controlled atmosphere have full muffles. Process heat is supplied by gas burners consuming regular city gas. Reducing gas for the controlled atmosphere is provided by an endothermic generator.

Quenching is done by dropping the springs into a stepped-up oil bath maintained at a temperature of 130° F. Oil any colder than this tends to cause excessive distortion, we have found.

Extremely light parts, which might tend to cling to the conveyor, are flushed off into a mesh basket by means of a low-pressure stream of quenching oil. The heavier parts fall off by gravity. Water cannot be used for this purpose because it might produce distortion or cracking of thin sections. Production averages about 175 pounds per hour per furnace.

We have recently installed also a new cast-link-belt type of furnace with a capacity of 500 pounds per hour. The operation of this is generally similar to the shaker-hearth type, except that different procedures for placing the parts on the conveyor are required. Small wire-forms which might tend to link together into chains, and flat springs which might become lodged in the joints between the links are handled in screen-wire bags which prevent these troubles from occurring.

Hardening Operations

Springs which are extremely delicate or which are particularly subject to distortion by reason of their shape are hardened in neutral salt in furnaces with a capacity of about 600 pounds per hour. Carbonate salt cannot be used because it would create a thin skin of low carbon steel on the surface of the spring. Even when neutral salt is used, the oxide arising from the work or from the steel pots must be compensated for by corrective additions.

The parts to be salt-hardened are spread on a screen in a thin layer, or in extreme cases are hung individually on racks. The thinness of the stock permits a very short heating time, between 3 to 6 minutes. After heating, the springs are tumbled into the quench individually by tipping the screens or racks over the quenching oil.

Before tempering, the hardened springs are cleaned, with the extent of the cleaning operation depending on the grade of finish that is to be given them. Some springs receive only a few minutes immersion in an alkaline soak-type cleaner. Higher quality springs which are going to be plated or given some other finishing process are degreased by soaking and then hosing them with trichlorethylene or if a continuous

(Continued on page 42)

NEWS TO HEAT TREATERS

(Continued from page 35)

quire no power, no maintenance and occupy a minimum amount of space.

Standard units are available in two models: the single barrel model with capacities from 25 to 150 CFH, and the double-barrel model ranging in capacities from 250 to 7,500 CFH. Special models can be manufactured for uses requiring capacities over 7,500 CFH.

These units have found wide use throughout industry during the last ten years for the following applications: annealing of stainless alloys; annealing of nickel, tantalum, iridium, osmium, and their alloys; sintering and annealing of magnetic alloys; copper brazing of Nichrome, Inconel and other stainless alloys; removal of oxygen from ammonia synthesis gases; and others.

For further information circle No. 8

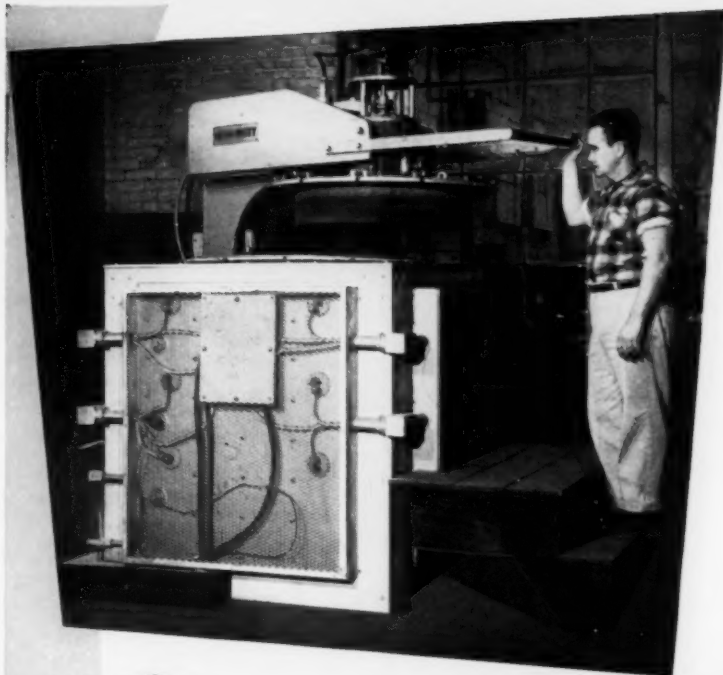
L. B. ROSSEAU HEADS AJAX

At a recent meeting of the Board of Directors of the Ajax Electric Company, salt bath furnace manufacturers of Philadelphia, Pa., Leon B. Rosseau was elected president and treasurer. He succeeds John E. Haig who will continue to serve Ajax on a consulting basis.



Mr. Rosseau needs no introduction in metal working circles. Formerly with the General Electric

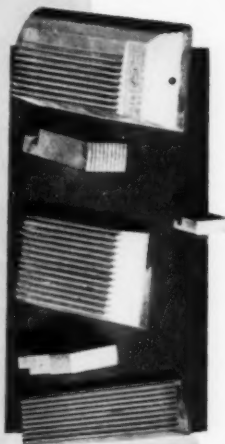
(Continued on page 40)



LANDIS MACHINE COMPANY
USES THIS HEVI-DUTY

VERSA-DUTY PIT FURNACE

- For uniform temperature throughout the densest of loads and
- Ease of duplicating results from load to load.



High Speed Steel Chasers
Tempered in Versa-Duty
Pit Furnace.

"We have noted a marked improvement in the quality of our products because of greater uniformity in heat treatment . . . not only throughout each load . . . but from load to load." In addition, Mr. Leckie-Ewing, the chief metallurgist at Landis Machine Company, Waynesboro, Pennsylvania, says that because the tempering cycle is so easy to control, they can temper to within ± 1 point Rockwell C.

If your products require nitriding, bright or steam tempering, annealing, bright or special bluing or non-atmosphere heat treating requiring temperatures to 1350°F, you can achieve outstanding results with Hevi-Duty's new Versa-Duty Pit Furnace.

Write for Bulletin 755 to find out how you can increase production, reduce rejects, save time, labor and floor space and eliminate many secondary operations.

HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces... Electric Exclusively
Dry Type Transformers Constant Current Regulators

ABSTRACTS

(Continued from page 20)
ing out the same operating with carbon powder.

Hardening plants which are called upon to deal with long runs of similar parts or of the same part can make very good use of gaseous carburising and carbo-nitriding in automatically-operated continuous furnaces. These furnaces must be sufficiently gas-tight to ensure that the necessary internal gas pressure can be maintained. The consumption of carburising gas naturally depends on the size and the gas-tightness of the furnace and lies between 25 and 50 cu.m./h.

Continuous Furnaces

Continuous furnaces can only be operated with carburising gas generated in the plant, since they need a large quantity of gas which must prevent the ingress of air from outside when the doors are opened. Unlike the pit furnaces described above, the continuous furnace can be fully mechanised in operation, giving a further reduction in labour costs and more comfortable working conditions. In addition, absolutely regular handling of the charge ensures an even better control of quality. It is possible also with continuous furnaces to add a harden-

ing bath, a pickling plant and a continuous tempering furnace to make the whole arrangement a completely integrated heat-treatment plant.

Continuous carburising and heat-treatment furnaces may be single or multi-strand units, consisting essentially of a heated furnace portion with gas seals at the inlet and outlet. The interior of the furnace is completely bricked and the outer steelplate casing and all lead-ins are incorporated in the roof and in the hearth which are electrically operated. To ensure regular carburising, gas-circulating fans are let into the hearth or the foot of the furnace at the carburising zone.

Furnaces in which steel may be heated to hardening temperature without either sealing or being decarburised on the surface are being more widely employed. These requirements necessitate a suitable protective atmosphere and a special furnace construction. A suitable protective atmosphere may be produced in an endothermic generator from town's gas or producer gas which at normal hardening temperatures will be neutral to steel.

Various types of furnaces are suitable for this purpose provided, of course, that they are gas-tight. In cases where a complete charge is to be quenched, then the type of pit furnace used for gaseous carburising may be used. The furnace cover is raised by means of the hydraulic mechanism and swung aside by hand, the charge extracted by means of the overhead crane and rapidly lowered into the quench tank placed near at hand. This must contain sufficient oil to lower the temperature of the entire charge without itself becoming overheated.

Revolving Hearth Furnace

For the continuous heating and hardening of single items the revolving hearth furnace may be used. This type of furnace has found a place in many hardening shops in the automobile industry and, according to the shape and

(Continued on page 41)

METAL TREATING

DFC

CAR BOTTOM FURNACES ARE ENGINEERED FOR BETTER SERVICE



▶ External Tube-Type Flues:

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- Reduced Maintenance Cost
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▶ Utilizing Engineered Refractory Applications

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LETTERS

TO THE



EDITOR

Dear Editor:

I would like to compliment you on your article in "Metal Treating", regarding the heat treatment of titanium by P. D. Frost of Battelle Memorial Institute.

I would like very much to receive three (3) reprints of this article. Would you please forward these to us or advise us where they can be obtained.

*Peter Zouareff
Research Supervisor
Reynolds Metals Company
Richmond, Va.*

Dear Editor:

The writer noted with interest the article "Hardness and Its Measurement" published in a recent issue of "Metal Treating." I would appreciate receiving two sets of tear sheets on this article.

You are to be commended on publishing such a complete discussion of a subject frequently misunderstood. We propose to use your article as a training aid for our personnel.

*Maurice J. Curtis
Head, Materials Evaluation Branch
U. S. Naval Ordnance Test Station
China Lake, Calif.*

Dear Editor:

I would appreciate receiving a reprint of your last four Heat Treating Hints covering pre-heating, austenitizing, quenching, and tempering operations. It is a simple but concise treatment of the fundamentals of tool hardening which I would like to circulate through our Tool section so the men can understand the processes involved more thoroughly.

*A. W. Kollosch
Process Engineer
Sylvania Electric Products, Inc.
Parts Division
York, Penna.*

Dear Editor:

I have had occasion recently to read your publication, "Metal Treating." I was quite impressed with its contents and would like to become a subscriber as soon as possible.

Would you please advise me of the proper steps necessary to enter a subscription. Thank you.

*K. J. Oswalt,
Metallurgist
American Brake Shoe Co.,
Los Angeles, Calif.*

Dear Editor:

At your convenience, could you please place my name on your mailing list for your "Metal Treating."

For the present, I am with the New England Metallurgical Corp.

of Boston, Mass. as Heat Treater.

Having seen the latest copy, there is no doubt that it will be a tremendous help for advancement and further knowledge in the art of Metallurgy.

*WILLIAM C. KUZMICH
South Boston, Mass.*

Dear Editor:

Please advise us if we may receive a regular copy of your publication "Metal Treating."

Your coverage is of real help to our engineering and production departments in their constant search for better equipment and methods.

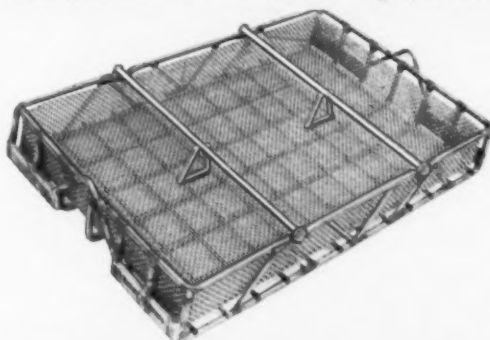
*Edwin G. Oliphant
Chief Engr.,
Graphic Arts Engineering
Seattle, Wash.*

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HEAT AND CORROSION RESISTANT

Patented Rolock design has changed the whole picture of furnace tray performance



- Travels easily and smoothly over hearth, with bottom bars acting as sleds.
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- Live-load to basket weight ratio often better than 10 to 1.
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- Longer furnace hour expectancy than any other known tray design.
- Lowest cost per hour of use.

Why not enjoy this superior performance in Ipsen, Lindbergh, Eclipse and other furnaces with this type of hearth? Place your next order for trays with Rolock. Also send for catalog of other heat treating equipment.

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ROLOCK INC., 1232 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

1RL50

NEWS TO HEAT TREATERS

(Continued from page 37)

Company as Industrial Heating Specialist he has been associated with Ajax Electric Company for 17 years. Recently he served as vice president and general manager. Widely known as a lecturer on heat treating subjects, he is a graduate of Cornell and Temple Universities and obtained his Baccalaureate Degree at the Sorbonne.

NEW SALES REPRESENTATIVE

Heatbath Corporation, Springfield, Mass., announces the appointment of International Chemi-

cal and Metallurgical Supply Corporation, of Fort Lauderdale, Florida, as their exclusive sales representative in Florida and Latin America for the sale of its complete line of Heat Treating and Metal Finishing products. Laboratory facilities and technical service will be made available through International Chemical and Metallurgical Supply Corporation, for customers in that area.

METAL SCIENCE BRAINPOWER POOL

Officers of the American Society for Metals in a recent letter to President Eisenhower an-

nounced formation of a "Free World Metal Science Brainpower Pool" and invited the U. S. Government to call upon it in aiding the stepped-up, scientific program now confronting the nation. Similar invitations are to be sent to heads of other major free world countries.

President Eisenhower has emphasized the need for closer cooperation between the United States and its allies in the field of science. The Metal Science Brainpower Pool has been created to speed the helpful exchange of important metals information around the world.

Membership in the "pool" will be comprised of the leaders of some 20-free-world, scientific, metal societies represented at the recent World Congress. Each society is to appoint a committee of correspondents who will relay pertinent information to the American Society for Metals which would act as a collection and redistribution agent for the 20 societies.

Areas in which the "metal science pool" will be of greatest service are: metallurgical education; manpower needs; processing techniques; conservation of materials; development of new metals for nuclear uses; and the contribution of ideas to help solve certain industry-wide metal problems.

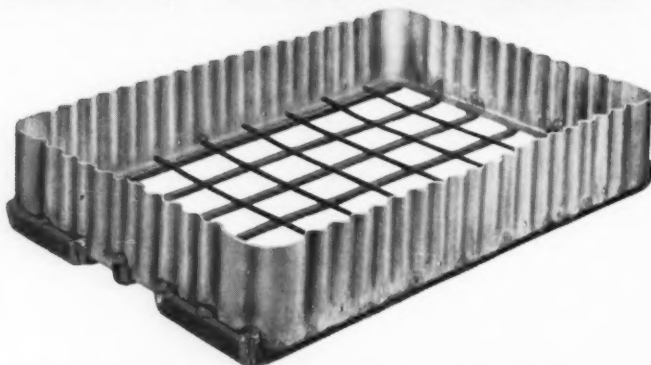
For further information circle No. 9

AUTOMATION

Heat treaters, metal tradesmen, industrial technicians, mechanical engineers, quality control men, and many other individuals concerned with modern metal working processes should find a new book published by the American Technical Society of particular interest and value to them.

Entitled *Automation in Practice* by S. E. Rusinoff, Professor of Mechanical Engineering at the Illinois Institute of Technology, the book provides an integrated survey of the latest automation techniques as they are actually applied in the various metal working processes. Automation is dealt with

Fabricated Heat and Corrosion Resisting Alloy Steel Boxes, Baskets, Fixtures and Retorts



Corrugated Alloy Boxes, Baskets and Retorts have increased the Service Life of Alloy Steel Fabrications used in the Heat Treating Industry and have proven to be economical.

We will cooperate with your Engineering Organization in designing your alloy steel and non-ferrous metal fabrications.

We have facilities to form $\frac{3}{8}$ " thick by 10 ft. long steel plate in our 500-ton Press Brake. We can form heavier plate in shorter lengths. We also have facilities for roll forming heavy and thin

wall cylinders or tubes to almost any diameter you specify.

Repeat purchase by prominent Heat Treaters is their endorsement of the superior performance and economy of our alloy metal fabrications.

We have 25 years experience fabricating for the Heat Treating Industry and corrosion resisting metals for the chemical and processing industries.

We solicit your inquiries for Boxes, Baskets, Trays, Radiant Tubes, Fixtures and Retorts, etc.

For further information send for our literature.

ALUMINUM and ARCHITECTURAL METALS COMPANY

Heat Treating and Industrial Processing Accessories Division
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in terms of the three basic functions of production: materials handling, processing, and quality control.

The first five chapters deal with the basic principles of automatic controls as they are relevant to various manufacturing processes. The next eight chapters are written from the point of view of particular processes, such as heat treating, metal working, metal cutting, casting, etc. The last chapter is concerned with devices and systems for achieving automatic inspection and quality control.

The book may be purchased for \$6.50 by writing directly to the American Technical Society, 848 East Fifty-eighth Street, Chicago 37, Illinois.

For further information circle No. 10

IEHA REPORT

November new orders for industrial furnaces totalled \$2,832,000 the Industrial Heating Equipment Association reported. This is 29% below the November 1956 total of \$3,986,000.

For the eleven months of the year new orders received amounted to \$51,013,000 as compared to \$73,509,000 for the similar 1956 period, a decline of 31%.

ABSTRACTS

(Continued from page 38)

size of the individual items, it can deal with a load of 200-300 kg./h. Unlike the earlier type of construction, this furnace is especially gas-tight and a very regular heat distribution throughout the hearth is obtained through a new arrangement of the heating elements.

To check the leakage of air into the furnace hearth when the door is opened, a curtain of burning gas is automatically projected across the opening when the door is lifted and, as a further precaution, to maintain the reducing atmosphere inside the furnace, a little ammonia is injected into the

hearth in certain cases. For hardening crown wheels, for example, the consumption of gas for the protective atmosphere will amount to about 10 cu.m./h., with an addition of about 2% of ammonia. For other items, e.g. stub-axle pins, the consumption of gas will only amount to about 5 cu.m./h. and no ammonia addition will be necessary.

To operate the revolving hearth furnace only one man is needed. When treating crown wheels, several wheels are placed in each hearth segment. They are taken in threes from the furnace at intervals of 1½ min. and laid in the presses. With a piece weight of

1.9 kg., a throughput of 230 kg./h. can be maintained. A continuous pusher furnace similar to that used for gaseous carburising may also be used for hardening in a controlled atmosphere. Fully automatic in operation, it is suitable for the treatment of fairly large items. In cases of need the automatic operation can be suspended and the movement of the charge controlled by hand.

The advantages of these automatic hardening units lie not only in the scale-free operation and absence of decarburisation but also in the absolute regularity of operation and avoidance of wasters. • • •

General Alloys' Radiant Tubes

built to last and last!

General Alloys' Radiant Tube Assemblies combine castings and fabrications to obtain the best features of each for optimum performance and service life.

The cast return bends give uniformity and extra strength at the area usually susceptible to early failure. The fabricated straight sections are light weight and provide maximum efficiency for heat transfer.

General Alloys combination cast and fabricated Radiant Tube Assemblies are available in many types of heat and corrosion resistant alloys, in a wide range of shapes and sizes to meet your specific requirements.

Extensive experience in high alloy castings and fabrications, together with modern production and testing facilities, is your assurance of superior results and satisfaction.

Call or write for detailed information or quotes.

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Specialists in high alloy castings and fabrications for 37 years

Special design combines casting and fabrication for maximum service life and efficiency

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WIRETEX fabricated PLATE POTS

*Last Longer—
Cut Operating
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WIRETEX PLATE POTS withstand temperatures up to 2100°! Cut neutral or cyanide bath costs! Last 15 to 20% longer! Operating costs drop 25 to 35%! Down time is almost halved!

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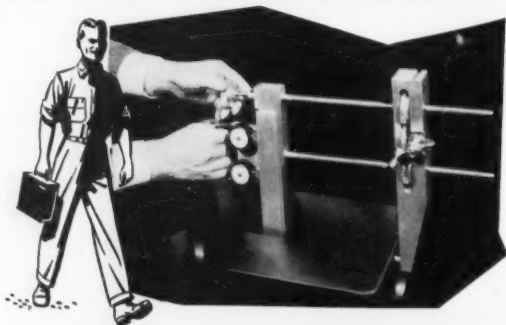
Before you buy any salt pot, or if you have other heat and corrosion resistant problems—SEE WIRETEX.

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HARDNESS TESTER compact and exact!

Inspectors simply carry this small, lightweight hardness tester to the work—instead of transporting heavy work pieces to a testing bench. Yet this Riehle portable hardness tester gives Rockwell readings as precise as any bench-mounted tester. Without obligation, let a Riehle representative prove this in your plant on certified calibrated specimens. Then try out on your own materials. Write Dept. MT-258.

Riehle TESTING MACHINES

A DIVISION OF

American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS

SPRING HEAT TREATING

(Continued from page 36)

operation is desired, by washing them in a hot detergent.

Tempering

Tempering, for the most part, is carried out in circulating air furnaces with belt-type conveyors 24 and 36 inches wide. These allow both close control and high production—2000 to 4000 pounds per hour, depending on the temperature required. When necessary, the springs can be positioned on the belt by hand, but the usual practice is merely to spread a thin, uniform layer of parts on the belt.

Other springs may be tempered in salt-tempering pots, which we have designed and built ourselves. Nitrate-nitrite salt is used. By having a number of small salt baths, each maintained at a different temperature, we obtain the necessary flexibility.

A third method of tempering, fixture-tempering, is useful for very high quality springs which must be held to extremely close tolerances. This procedure gives considerably more successful results with springs than it does with rigid machine parts.

Stress Relieving

Two general types of stress-relief treatment are used, depending on the result to be accomplished. The first is carried out at relatively low temperature, 450° F., for many steel materials. This treatment, in which time is not critical, is used to restore the elastic limit of cold-worked metals. The importance of this effect can be seen in music wire in which, under certain conditions, the set point actually doubles by the proper stress relief.

Contrasted with this treatment is the high-temperature treatment which may be done on cold-worked materials below the softening point, or on quenched and tempered steel after cold-forming. In the latter case, the temperature used is the highest which will not cause loss of strength. This treatment gives the best relief from undesirable tensile stresses such as those left on the inside of cold bends. Often the use of a spring tends to open such bends and results in premature setting if the stress has not been thoroughly relieved.

Finishing Operations

Finishing operations range from simple oiling of the gray-colored tempered spring to coloring, blasting, tumbling, or plating. Coloring is a multi-step operation. First, a chemical strip removes the temper oxide; then a tumble in sawdust removes smut and imparts a luster; and finally, a temper at about 500° F. provides a straw or blue color, depending on time and temperature. This coloring operation has no influence on the hardness of tempered spring steel.

Cleaning for plating is much more critical. If any oil has been left on during tempering, it hardens into a carbonized enamel which is impossible to remove by inexpensive methods. Also, if the oxide is too

heavy, it cannot be easily removed by normal pre-plating cleaning. Both of these conditions may lead to possible over-pickling and cause permanent damage, and may also result in increased hydrogen embrittlement. Because of these factors, oil is not allowed to bake on and temper oxide, if formed at higher temperatures, is removed by the same procedures used for coloring.

Shot-blasting is carried out in the heat treating department. This operation is followed by a strain relief treatment. A large proportion of springs is blasted with "Wheelabrators", because we discovered many years ago that peening substantially increases the fatigue properties of a spring. It has been found that as long as the springs are well covered by peening of sufficient intensity, the exact time is not critical.

Tumbling is done in open octagonal steel barrels to remove burrs, round corners, and polish. Typical parts which are tumbled are spring washers and simple stampings. Silicon carbide or Alundum shapes are used for finishing holes in washers, and slugs are sometimes included to promote better tumbling.

In any finishing operation it is necessary to consider the stresses generated in the surface layer. In grinding, for example, tensile stresses are frequently encountered. Tumbling may impart a slight compression if enough pounding action is obtained, but generally this does not affect a deep layer of metal. If the surface is in compression, the condition is favorable to good life, but setting may begin at a low stress. Shot-blasting is an excellent example of this. In this case, a low temperature stress-relief treatment is used to restore the resistance to set without removing the beneficial compressive stresses. . . .



JANUARY-FEBRUARY 1958

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FLEXIBLE POWER PRESSES

Greater versatility for:

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10 and 20 tons

ELIMINATES WASTE MOTION: Part is not moved in these new horizontal models. Easier to load.

able speed rams and indicators located where needed.

SELECTIVE, FAST ACTION: Single or multiple head, vari-

SENSITIVE CONTROL: Air or hydraulic, variable pressure, automatic indicators eliminate guesswork in straightening.

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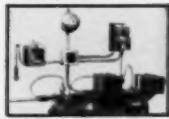
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Where fire hazards are severe and access limited... play safe! Be ready and secure with a fast action Randolph Automatic Fire Extinguishing SYSTEM!

Write today for Randolph's free FIRE HAZARD INDEX listing equipment safeguards for 580 typical fire hazards. Randolph Laboratories, Inc., 9 East Kinzie Street, Chicago 11, Illinois.



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For your copy circle
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HYDRAULIC CASTABLE REFRACTORY

The Chas. Taylor Sons Co., a Subsidiary of National Lead Company, has announced the publication of its latest bulletin giving detailed information on uses, properties and directions for use of TASIL No. 413 Hydrocast.

For further information circle No. 11

RESEARCH IN METALLURGY

The Battelle Memorial Institute, Columbus, Ohio, has published a 26-page folder entitled *Research in Metallurgy*.

The booklet explains all of the various fields of research in which they are active and explains how its staff of 2,500 engineers and scientists conduct basic, theoretical, developmental, engineering, and pilot-plant studies in all branches of metallurgy.

The Institute contracts with individuals, industrial firms, Government agencies, trade associations, and technical groups to investigate specific problems.

For further information circle No. 12

AIR AND GAS DRYERS

Three bulletins recently released by C. M. Kemp Mfg. Co., Baltimore, Maryland, describe their dryers for removing moisture from air and other gases. Water is removed by adsorption with a solid granular desiccant, and reactivation is accomplished with heat. One bulletin describes the steam reactivated type; another, the electric reactivated type; and the third, a convection dryer.

For further information circle No. 13

HIGH-TEMPERATURE ALLOYS

Two new 28-page properties booklets are now available for "Haynes" alloy No. 25 and "Hastelloy" alloy X.

"Haynes" alloy No. 25, a wrought cobalt-base high-temperature alloy, has been used for many jet engine applications. In addition the alloy has given good service in a variety of industrial furnace applications.

"Hastelloy" alloy X is a nickel-base high-temperature alloy available in both wrought and cast form. It has proved extremely useful in a number of heat-treating applications because of its high oxidation resistance at temperatures up to 2200 deg. F.

Both booklets contain sections on physical properties, short-time tensile data, and stress-rupture and creep data.

For further information circle No. 14

NEW HEAT TREATING METHOD

A 12-page folder "The Tricarb Heat Treating Method" describes Leeds & Northrup's new protected-quench furnace equipment.

This equipment features Microcarb atmosphere control, Speedomax temperature control and a controlled quench. This combination is said to make possible significant quality improvements in production heat treating. With the new L-O voltage heaters the equipment can be used interchangeably for controlled case carburizing, carbonitriding, carbon restoration, homogeneous carburizing or hardening.

For further information circle No. 15

HEAT TREATING DATA BOOK

The Industrial Furnace Division of Sunbeam Corporation, Chicago, Illinois, has published an eighty-two page book containing charts, tables, diagrams and factual data on late steel and aluminum specifications, characteristics and applications, heat treatments, heating time allowances, hardness and tempering conversion tables, carburiz-

ing, case hardening, cyaniding, quenching notes, furnace capacity information, melting points of common metals, etc.

For further information circle No. 16

BLAST CLEANING

Automated techniques for high speed blast cleaning, construction features of Rotoblast units, layout aids, and a special section on abrasive coverage are presented in a new 20-page reference bulletin offered by the Pangborn Corporation, Hagerstown, Md.

For further information circle No. 17

AID FOR FUEL PROBLEMS

A comprehensive cost-free service providing practical assistance on problems involving fuels, lubricants and other products of petroleum is being offered to industrial and commercial users of petroleum products by Gulf Oil Corporation, Pittsburgh, Pa.

Goal of this broad engineering program — Gulf Petro-engineering Service — is to bring their engineering and research facilities closer to problems relating to the use of different petroleum products. A 24-page illustrated booklet describing the details of this service is available.

For further information circle No. 18

FOR SALE

LINDBERG CAR TYPE TEMPERING furnace. Gas Heated type No. 481260—GCH. 48" wide x 12' deep x 5' high; 5HP. Fan motor, fan safety switch and Chromel-Alumel thermocouple; operates to 1250°F. Complete with automatic controls and safety equipment. Excellent condition. \$6000.00 f.o.b. our plant.

WALTER SCOTT & CO.

Division of Wood Newspaper
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"OK... IT'S SALTED TO TASTE, NOW HOW ABOUT A DASH OF PAPRIKA?"

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FOR ALL
HEAT-DEPENDENT
OPERATIONS

*looks like a crayon... marks
like a crayon... tells temperatures
like a precision instrument!*

Here's a unique marking crayon that helps you determine and control working temperatures from 113° to 2000° F. Available in 63 different melt ratings, TEMPILSTIK° is accurate within 1% of its rated melting point.

TEMPILSTIK° is also available in liquid and pellet form. Write for information and sample pellets, stating temperatures of interest.



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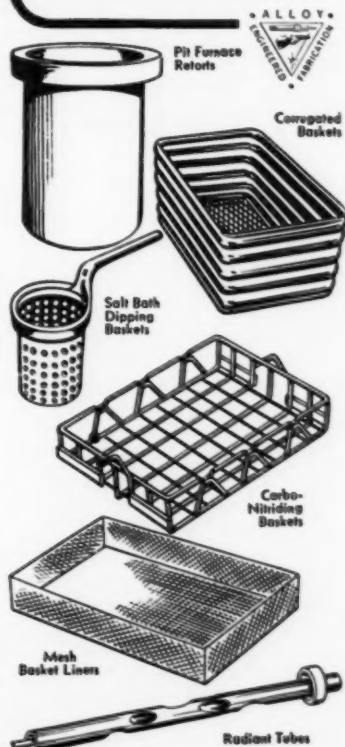
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Tools *from Stock!***

MISCO heat-treat process equipment is engineered and fabricated by qualified specialists in the field of heat-resisting alloy materials.

With a wide variety of job-proven heat-resisting steel products available for immediate delivery, Misco Fabricators provide a real service to heat-treaters, who no longer need carry an expensive inventory of equipment.

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HARDNESS TESTERS

The Riehle Testing Machines Division of American Machine and Metals, Inc. has published two bulletins dealing with their hardness testers.

One 4-page bulletin deals with their portable hardness tester for "on the spot" Rockwell readings in the A, B, C, D, F, and G scales; it is well illustrated and gives various specifications.

The other describes and contains a cross-sectional view of their hydraulic Brinell hardness tester which is of the dead weight type and fully hydraulic in operation. Although hand operated, it is said

to equal power-driven machines in convenience and to excel them in maintenance of accuracy.

For further information circle No. 19
TEMPERING STEEL

An eight-page reprint of an article which appeared in "Metal Treating" entitled *Tempering of Hardened Steel* by K. E. Johansson and G. Molinder is now available.

The article explains the tests conducted by the authors at the steel mills of the Uddeholm Company in Sweden, and is illustrated by thirteen graphs and two tables. Both authors are heads of the metallurgical laboratories at the company's mills in Sweden.

For further information circle No. 20

INDUCTION HEATERS

Magnethermic Corporation, Youngstown, Ohio, has published a bulletin on Electronic Induction Heaters. Eight pages contain specifications on 15, 30 and 40 KW; basic components; optional features; guide to induction brazing and soldering; frequency selector chart; static hardening curve; and other engineering information.

For further information circle No. 21

HEAT TREATING ALLOY FABRICATIONS

A new catalog features all types of fabrications designed to meet industry's need for alloys that must be used in high temperature ranges and withstand extreme corrosion conditions. Wiretex Manufacturing Co. of Bridgeport, Connecticut, makes all types of heat treating fixtures, retorts, baskets, trays, boxes, plating equipment baskets, tanks, etc., and the fabrications illustrated in the new catalog represent a few of the wide variances possible, ranging from small baskets to hold jewelry parts to baskets to hold five tons.

For further information circle No. 22

HEAT TREAT BURNERS

The Selas Corporation of America has recently published a new 10-page bulletin, "Selas Superheat Burners," which describes their burners for producing high heat release to localized areas of workpieces for flame-hardening, flame-annealing, brazing, pre-heating, descaling, and other open heat treating.

For further information circle No. 23

COMBINATION ROCKWELL TESTERS

A new bulletin describing the four Kentroll Combination Hardness Testers has been announced by The Torsion Balance Company, Clifton, N. J. Each of these hardness testers makes both regular and superficial Rockwell Tests and costs about the same as "single-function" testers. A complete range of standard and accessory equipment is also described in this bulletin.

For further information circle No. 24

METAL TREATING

reduce costs

improve production

Proved in thousands of installations

YOUNG BROTHERS OVENS



Light metal alloy
aging and solution
heat treating ovens.

● Young Brothers Ovens and Furnaces designed for heat treating requirements are designed and built to improve the quality of the finished product and provide savings in time, fuel and materials. Each one is engineered to meet the specific need regardless of the process, material or product.

The proven dependability of Young Brothers Ovens in thousands of installations during a period of 60 years is your assurance of the finest results at lower overall costs. A wide variety are available for Annealing and Tempering, Drying and Impregnating, Aging, Normalizing, Preheat, Stress Relief, Homogenizing and for other processes.

Write for Bulletin 157

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in this
picture!



The publisher of this magazine is often asked what kind of a man you are . . . and how many like you are receiving his magazine. Why is he asked?

Because the *advertisers* (whose money is his chief income) insist upon knowing the types of people (by industry or profession, by title) for whom the magazine is edited — and how many are getting it.

In order to standardize on the presentation of such information to advertisers and to have its accuracy vouched for by a disinterested third party, nearly 450 publishers have joined some 200 leading advertisers and advertising agencies in a non-profit organization called Business Publications Audit.

The purpose of BPA is to assure advertisers . . . by frequently checking and rechecking . . . that each member publisher is indeed distributing his magazine, in the *numbers* promised, to the *types* of men he promised would receive it.

The BPA symbol in this magazine means that *you belong* . . . that because of your occupational interests you are qualified, in the eyes of the advertisers, to receive it.

The advertiser can thus tell whether he's getting his money's worth.

The publisher has a better sales story to prospective advertisers because his magazine is "audited."

And you, the reader, get more value from the magazine because both the advertisers and editors, knowing what your special occupation is and what your interests are, are better able to prepare advertising and editorial material that will be most informative and useful to you.

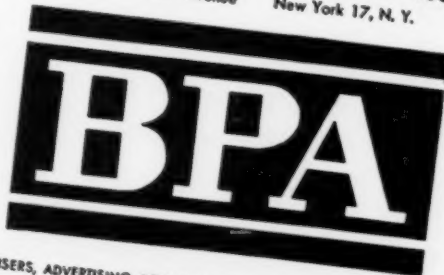
What you can do

Publishers and advertisers frequently write to magazine readers to learn what kind of articles and advertisements appeal most. Cooperate with them — will you? — by answering their questions . . . in the interest of better communications between makers and markets.

**BUSINESS PUBLICATIONS
AUDIT OF CIRCULATION, INC.**

420 Lexington Avenue

New York 17, N. Y.



A NON-PROFIT, TRIPARTITE MEMBERSHIP CORPORATION OF ADVERTISERS, ADVERTISING AGENCIES AND BUSINESS PUBLICATIONS

Sound Familiar?



SHOP TOURS HAVE A GOOD REACTION... ALWAYS GIVE MUTUAL SATISFACTION!

THAT WAS AN EYE-OPENER! -DIDN'T REALIZE I WAS HANDING YOU SUCH HEADACHES. FROM NOW ON I'LL DESIGN WITH YOU PEOPLE IN MIND!

THANKS, HERMAN. JUST THOUGHT YOU OUGHT TO KNOW.



Bata cuts mold cleaning time in half with Pangborn Hydro-Finish

Bata Shoe Co., Belcamp, Md., used to clean shoe molds by pickling. For a better cleaning job, Bata replaced this process a year ago with Pangborn Hydro-Finish. Today this machine gives Bata top quality cleaning, does the job in half the time required by pickling and has required "no maintenance whatsoever." Also, acid disposal problems have been eliminated.

Says Mr. Albert Kotras, Research, "We thought it was sales talk but the Hydro-Finish has lived up to every claim the Pangborn representative made." Convinced by the performance of its Hydro-Finish machine, Bata management now plans to order a second one.

Today, through new design and use of air jet slurriers, Pangborn Hydro-Finish costs less originally, costs less to maintain and gives you easier handling and added efficiency. Write for Bulletin 1403 to PANGBORN CORP., 3600 Pangborn Blvd., Hagerstown, Md. Mfrs. of Blast Cleaning and Dust Control Equipment.

USE PANGBORN HYDRO-FINISH FOR:

Deburring • Surface finishing • Finishing threaded sections • Improving cutting tool life • Maintaining dies and molds • Removing grinding lines • Removing heat treat scale • Preparing surfaces for coatings, platings, etc.

Pangborn

BLAST CLEANS CHEAPER

SALT BATHS

(Continued from page 6)

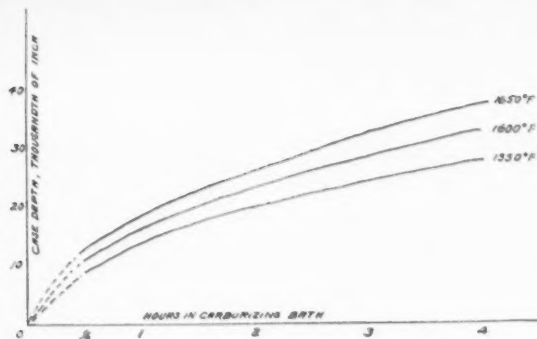


Chart #2—The depth of case on a low carbon steel at various times and temperatures.

a fluffy blanket on top of the bath and prevents rapid oxidation and breakdown of the sodium cyanide. Also, it prevents radiation heat losses, thus contributing to the efficiency of the operation. We may add that without a carbon blanket, the sodium cyanide breaks down at 1550°F. at the rate of 3% per hour. With a suitable carbon blanket the breakdown is 0.25% per hour. Excessive amount of carbon cover should be avoided, as it may interfere with the work going in and out of the bath. If any of the carbon cover adheres to the work, it may retard the quench and cause soft spots.

One thought must be stressed here. Since a liquid carburizing bath has to break down, even though slowly, to provide carbon, it needs to be replenished during the day's operation, to compensate for the breakdown. A definite amount of fresh salt should be added to maintain a workable strength of the bath. This amount to be added depends upon the size of the pot and the temperature of operation. Normally, for an eight hour's operation at 1550°F., the addition should be around 6% of the contents of the pot. Usually the dragout permits such additions. However, if the dragout is very slight, some of the bath from the pot, preferably from the bottom should be removed and discarded.

No liquid carburizing bath, no matter how strong and well compounded, will last indefinitely and needs to be replenished regularly. To expect otherwise would be like the situation when a person drawing checks against his account, without periodical deposits to cover his drafts, will find eventually his balance to be zero. In any carburizing bath, we start with a fixed limited amount of carbon. Whether any work is processed or not, the bath is slowly decomposing and the carbon is dissipated. Unless the bath is regularly replenished, to cover the draft so to speak, the bath will reach a zero point in carbon, and ceases to be carburizing. • • •

(The concluding instalment will be published in the next issue.)

HAMLER

FIRST with 99.999% PURE METAL TREATING GRADE ANHYDROUS AMMONIA

Hamler Industries, Inc. is still in the lead with another FIRST !!!

Our total requirements of Anhydrous Ammonia are now being supplied with a new and purer grade never before offered to the Metal Processing Industry.

Hamler is the only distributor to Industry being supplied with Metal Treating Grade Anhydrous Ammonia of the following unsurpassed specifications:

Purity	99.999% Minimum by weight
Moisture	0.001% Maximum
Oil	2 PPM Maximum

OTHER HAMLER "FIRSTS" TO INDUSTRY

FIRST to specialize in a Service offering only one high grade purity Ammonia.

FIRST to offer bulk tank truck delivery.

FIRST to offer a completely equipped storage tank on a loan basis.

FIRST to reduce Ammonia costs.

FIRST distributor of Ammonia with adequate bulk storage plants to give prompt and efficient service.

Discover what Hamler Service can mean to you —call or write one of our offices for complete information.

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TOOL STEELS

BETHLEHEM STEEL COMPANY
Bethlehem, Pennsylvania

STANWOOD RETORTS

of new
COR-WAL
construction
give you:

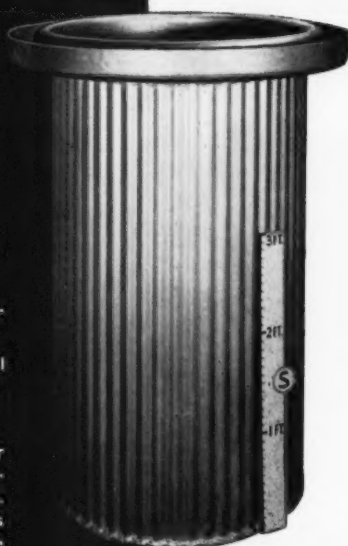
- Lighter weight—yet stronger
- Longer service life
- Sides are heat-resistant corrugated rolled metal.
- One piece cast alloy top seal of special reinforced design.

Cor-Wal Construction—another Stanwood "first"—has proved itself in exhaustive tests on the job. Once again Stanwood engineers afford you maximum performance and economy.



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Advertiser	Page
Hevi-Duty Electric Company 37 Agency—Bert S. Gittins Advertising	
Holden Company, The A. F. Inside Front Cover	
Houghton & Co., The E. F. 12 Agency—Beaumont, Heller & Sperling, Inc.	
International Nickel Company 13 Agency—Marschalk and Pratt	
Ipsen Industries, Inc. 10A-B Agency—Fensholt Advertising Agency	
Jelliff Mfg. Co., The C. O. 23 Agency—William Hill Field Advertising	
Metal & Thermit Corporation 45 Agency—RAF Advertising Incorporated	
Metal Treating Institute 26-27	
Misco Fabricators, Inc. 45 Agency—L. Charles Lussier, Inc.	
Norton Company, The 31 Agency—James Thomas Chirurg Company	
Pangborn Corporation 48 Agency—Vansant, Dugdale & Company	
Park Chemical Company 7 Agency—Marvin Hahn, Inc.	
Randolph Laboratories, Inc. 43 Agency—Symonds, MacKenzie & Company	
Riehle Testing Machines Division 42	
American Machine & Metals, Inc. Agency—The L. W. Ramsey Advertising Agency	
Rolock Inc. 39 Agency—The Edward W. Robotham Company	
Sinclair Refining Company 28 Agency—Morey, Humm & Warwick, Inc.	
Stanwood Corporation 52 Agency—Tri-State Advertising Company, Inc.	
Surface Combustion Corporation 19 Agency—Odiorne Industrial Advertising, Inc.	
Wiretex Manufacturing Company, Inc. . 42 Agency—Bass & Company, Inc.	
Young Brothers Company 46 Agency—Allied Advertising Agency Inc.	

Index To Advertisers

Advertiser	Page	Advertiser	Page
Ajax Electric Company 25 Agency—The Harry P. Bridge Company		Cincinnati Sub-Zero Products 23 Agency—Baer, Kemble & Spicer, Inc.	
Allied Chemical and Dye Corp. 24 (Nitrogen Division) Agency—G. M. Basford Company		Cities Service Oil Company 21 Agency—Ellington & Company Inc.	
Aluminum and Architectural Metals Company 40 Agency—Sales and Merchandising Counselors		Denver Fire Clay Company 38 Agency—Mosher, Reimer, Williamson Advertising Agency, Inc.	
American Cyanamid Company (Metal Chemical Section .. Outside Back Cover Agency—Hazard Advertising Company, Inc.		Eclipse Fuel Engineering Company 33 Agency—Howard H. Monk & Associates	
American Gas Furnace Company Inside Back Cover Agency—Advent Associates, Inc.		Garden City Fan Company 36 Agency—The L. W. Ramsey Co.	
Armour Ammonia Division 15 Agency—Foote, Cone & Belding		General Alloys Company 41 Agency—Roy Elliott Company	
Bethlehem Steel Company 32 Agency—Jones, Brakeloy, & Rockwell, Inc.		General Manufacturing Company 43 Agency—F. B. Hubert Advertising Counselors	
		Hamler Industries, Inc. 49	

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BRAZING - ANNEALING - HARDENING of stainless steels



AGF Model 50 Controlled Atmosphere FURNACE

Factory trained engineers and metallurgists will promptly answer your written questions or call upon you without obligation. AGF representatives are in major industrial areas.

AGF Model 50 Furnaces employ the most advanced combustion system design to achieve the greatest measure of flexibility and uniformity required for various work. The extended range of Model 50 Furnaces permits bright annealing, copper and alloy brazing and atmospheric hardening of regular and stainless steels — and in addition silver soldering or annealing of ferrous, non-ferrous or precious metals.

AGF engineering and quality construction features — a recognized standard in the metal-working industry for over 79 years — are your assurance of dependable performance. All AGF Furnaces have the built-in flexibility to permit the performance of tomorrow's as well as today's production requirements.



"Pioneer inventors and manufacturers of industrial gas heat treating equipment and accessories since 1878."

TEAR OFF AND MAIL

AMERICAN GAS FURNACE CO.

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☐ Send literature about AGF Model 50 Furnace

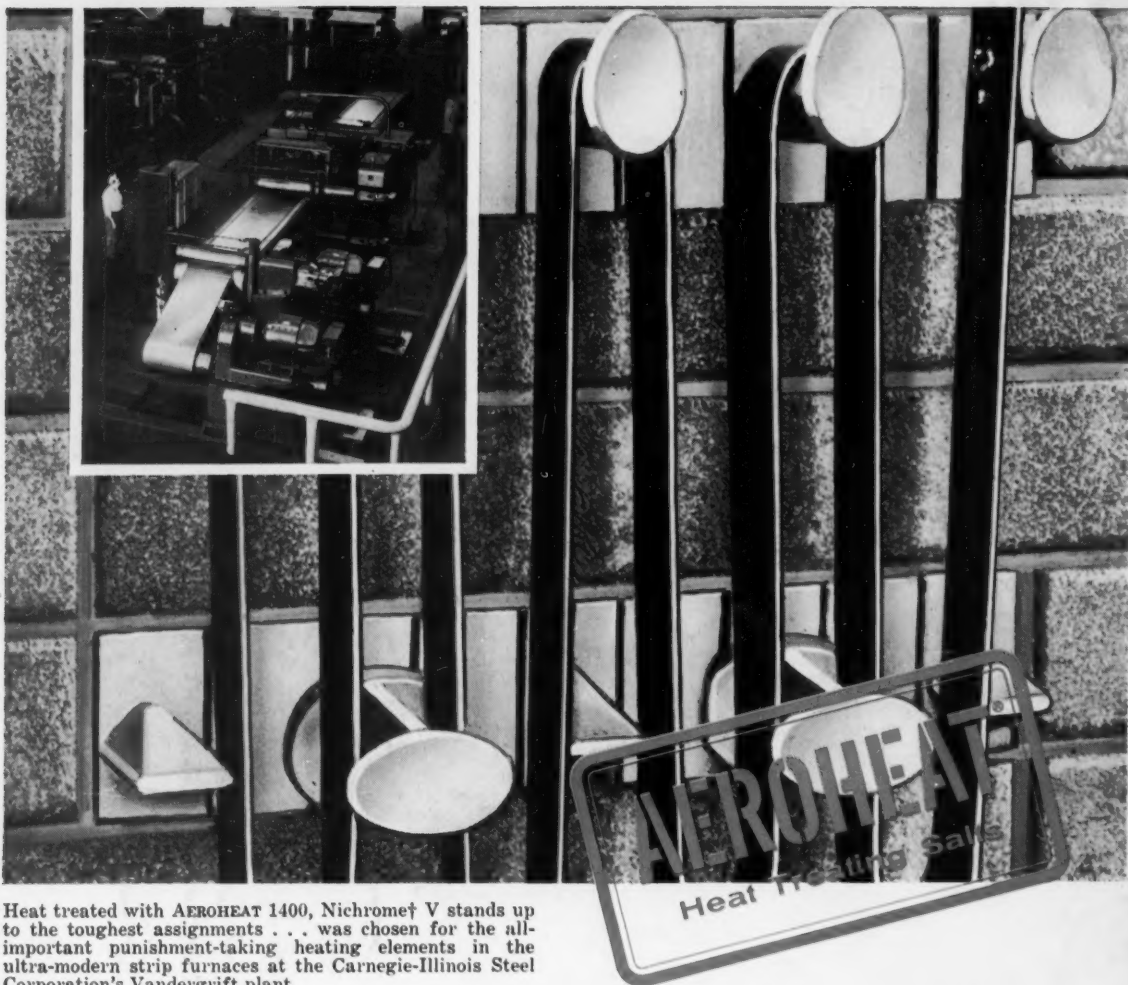
☐ Send representative

My Name Title

Company

Street City State

We wish to Product or material



Heat treated with AEROHEAT 1400, Nichrome† V stands up to the toughest assignments . . . was chosen for the all-important punishment-taking heating elements in the ultra-modern strip furnaces at the Carnegie-Illinois Steel Corporation's Vandergrift plant.

WHY DRIVER-HARRIS HEATING ELEMENTS RATE WORLD'S TOUGHEST ASSIGNMENTS

The leading manufacturer of electric heating and resistance alloys, Driver-Harris Company of Harrison, New Jersey, knows the vital importance of selecting the right heat treating compound. That's why the company chooses from Cyanamid's comprehensive range of AEROHEAT compounds to give each alloy its particular characteristics.

Driver-Harris, for example, uses AEROHEAT 1400 in the manufacture of Nichrome† V, universally recognized as the outstanding heat-resistant and corrosion-resistant alloy. AEROHEAT 1400 plays a big part in giving Nichrome† V its ex-

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You too can upgrade your products, lower your costs with AEROHEAT Heat Treating compounds. For details, just call your Cyanamid Metal Chemicals representative.

Cyanamid's heat treating compounds include:

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American Cyanamid Company, Metal Chemicals Section, 30 Rockefeller Plaza, New York 20, New York. In Canada: North American Cyanamid Limited, Toronto and Montreal

† T.M. Driver-Harris Co.

* T.M. Cyanamid

METAL CHEMICALS SECTION

CYANAMID

